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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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MIMICRY IN BUTTERFLIES AND MOTHS.

Researches on Mimicry on the Basis of a Natural Classification of the Papilionidæ. Part ii. *Researches on Mimicry.* By the late Dr. Erich Haase, Director of the Royal Siamese Museum in Bangkok. Translated by C. M. Child, Ph.D. Pp. 154 and 8 coloured plates. (Stuttgart: Ernin Nägele. London: Baillière, Tindall, and Cox, 1896.)

IT is, in some respects, a matter for regret that this important and painstaking work has appeared. The treatment falls far short of the pretensions of the author, and is marred by numerous grave imperfections; and yet the plan is so comprehensive, and the amount of valuable detail so great, that the appearance of a better work will probably be long delayed. The detail which forms the real merit of the work is piled together in a most inartistic manner, so that every reader, except the serious and determined student of the subject, cannot fail to be repelled, and even to the latter the task will be most tedious. And yet there is no subject which is capable of being made more interesting and attractive—alike to the beginner and the advanced student—than mimicry.

The volume deals with mimicry wherever it is found in organic life, beginning with a brief mention of it among flowering plants, and then giving a short account of its occurrence in Arachnida, Orthoptera, Hemiptera, Hymenoptera, Neuroptera, and Coleoptera. It is then treated at great length and detail in the Lepidoptera, the subject being divided on a geographical basis into the models and mimetic forms of (1) the Indo-Australian, (2) the African, (3) the Nearctic, and (4) the Neotropical regions. The mimicry of Coleoptera and Hymenoptera by Lepidoptera is next briefly considered; then follows a short account of mimicry in Diptera, Mollusca, Batrachia, and Reptilia (of the four above-named regions), Birds and Mammals. The memoir concludes with an important general section, dealing in various sub-sections with the history and origin of mimicry in Lepidoptera, and the objections which have been raised against it, and with the biological significance of mimicry in the animal kingdom and its relation to other forms of protective adaptation to the environment.

The vast display of facts and details upon all points prepares a reader to believe that the speculative part of the work will be marked by extreme caution, and guarded by the most scrupulous regard for all available evidence. When, however, the author does begin to speculate, he shakes off all restraint, and indeed in most cases all prudence, and makes the rashest suggestions as calmly as if they were well supported. Good examples of this are to be found in most of his confident statements as regards the past history of the warning and mimetic groups in the Neotropical region (pp. 116–119); in the calm assertion that the variations which have been developed into mimicry were due to "an unfavourable condition of the species, which would cause variations among the females"; in the conclusion, for which the most inadequate evidence is offered, that "the development of the *Neotropinæ* has reached and passed its maximum" (p. 118). We do not often meet with this combination of rash speculation with an almost tedious collection and heaping together of facts, in English works, perhaps because we are less patient in the latter, rather than more cautious in the former.

One very irritating feature of the work is the positive statement of conclusions without any recognition or discussion of the obvious difficulties which they encounter. Thus Haase's contention that what he calls the *Melinæa* type of colouring—

> "may be regarded as a characteristic expression of the special, purely physical and chemical influences of the Neotropic climate on a type of colouring originally black and white"—

is opposed by the want of evidence that effects so produced are hereditary—a difficulty which, at least, merits consideration. Very similar, and even more annoying, are the confident statements which are upset by other statements in a different part of the work. Thus, on p. 138 we are told in spaced type that "in all species which are mimetic in both sexes the female resembles the model more closely than does the male"; while in other

parts the author admits the existence of large groups in which both sexes are equally mimetic. Again, his frequently-stated dictum, that mimicry begins with the female, is controverted by the subsequent admission that he is unable to offer any sufficient proofs of it in some of the most important groups.

The author has the most extraordinarily exaggerated notions of the importance of his own contributions to the subject, and he frequently speaks as if he were one of its pioneers, and, with cool assurance, ranges himself beside Bates and Wallace, or more frequently himself claims the credit for work which they had long before accomplished. Thus, on p. 93 he speaks of

"the fact which I have so firmly established, viz. *that all mimetic modifications appear first in the female, this sex being so much more important than the male for the preservation of the species.*"

In the first place, this principle is by no means firmly established as of universal occurrence; in the second, all that is really true in the statement was brought forward long ago by Wallace. Again, on p. 100 he states with all the insistence of spaced type:

"Through my observations in Siam I have arrived at the general conclusion that those larvæ which conceal themselves most carefully or show the most perfect protective adaptation are probably those most sought by their enemies on account of their especial edible qualities."

By this unjustifiable or, accepting the most favourable interpretation, ignorant claim to a principle enunciated many years ago by Wallace, Haase puts in a most unfavourable light the really useful work which he has done in the comparatively humble position of a supporter of a well-established and thoroughly accepted conclusion.

Again, on p. 123 he calmly appropriates a principle which we owe to Bates:

"Thus, we find in these cases also a confirmation of our principle that it is always the rarer immune species which mimics the more common form in order to escape pursuit in its swarms."

The examples quoted above sink, however, into insignificance beside the passage which opens the section "Objections to the Theory of Mimicry" on p. 123: "The attacks on the hypothesis held by Bates, Wallace and myself, viz. that mimicry is the result of natural selection, &c." Having gone so far, Haase was no doubt astonished at his own self-effacement in thus placing his name after the distinguished naturalists to whom we are really indebted for something more than a patient accumulation of facts. Others will, however, feel that it is a piece of sheer impudence for Haase thus to range his name beside the pioneers of the subject to the exclusion of their true compeers Fritz Müller and Roland Trimen.

For a keen naturalist possessing a wide acquaintance with insect form and insect life, Haase shows a strange want of grasp of the well-known principles which operate among living beings in the natural state. Thus he continually speaks as if the protective qualities which accompany a warning appearance confer absolute immunity—an immunity as complete for the larva against the attacks of parasites as for the imago against insect-eating enemies. The term "immunity" ought not to be used at all with regard to these forms, unless very carefully qualified. Such a heading as that on p. 96, "Origin of Mimicry between Non-immune and Immune Lepidoptera," is liable to convey a very false impression of the facts of nature. We may feel confident that the average ratio of extinction to survival is the same in both groups—that a pair of the so-called immune species, in spite of all their numerous progeny, are upon the average succeeded by a pair only. The warning colours and the qualities they imply do indeed secure a high degree of immunity from the attacks of certain enemies, especially during certain stages, but other enemies have acquired the hardihood necessary to make use of the abundant and easily captured prey. So far from accepting Haase's dictum (p. 97) that

'it is certain that the early stages of immune butterflies suffer in general less from parasites than those of other Lepidoptera,"

we may feel confident that the reverse is the truth. Haase brings before us an unworkable theory according to which the species with warning colours must continue to increase in numbers, indefinitely from generation to generation. No doubt at the very origin of this special means of defence the species concerned were enabled to increase largely in numbers, and very many of them have reached a condition of equilibrium as abundant and dominant species. But as soon as this equilibrium is reached there is no interference in the general law that the amount of extinction keeps down the numbers of the species to a certain average; and we may therefore feel sure that the relative immunity from the attacks of certain enemies, and during certain stages, is compensated by the excessive attacks of other enemies, and during other stages; and furthermore, that during the progressive growth of the numbers of the species, each increase was attended by increased attacks until equilibrium was reached. Haase depicts a state of affairs which would cause an indefinite increase, and could lead to nothing but the extinction of the food-plant, and consequently the disappearance of the species. The keen observation of Belt detected some of the ways in which the numbers of unpalatable butterflies are kept down; for he noticed a flower-haunting spider which eagerly devoured them, and a wasp which stored them up in its nest. In order to support his views of extreme immunity, Haase makes, as regards these observations of Belt, the absurd suggestion that "it is perhaps possible that the mimic was mistaken for the model."

Haase shows a similar want of insight in his contention that mimicry and protective resemblance arose in a time of great struggle which has now ceased to exist. He concludes his work in these words:

"It is probable that all these resemblances to the moving or motionless and the living or lifeless environment have arisen in the interest of the preservation of the species from extinction during periods when the struggle for existence was most bitter, and from chance variations which corresponded to this purpose and whose further development was aided by natural selection and fixed by inheritance. Under these circumstances it appears then, to close with the apt words of Brauer, that 'the struggle for existence being ended, the forms reach a state of equilibrium, and the living species (being under the same conditions) are preserved from extinction.'"

All this is the most utter folly; the struggle for existence is now what it has ever been, fluctuating in degree, but always severe, and we know that when a species is shielded from the struggle as regards any part of its organisation, that part is very far from maintaining an equilibrium unchanged.

The suggestion that the unpalatable qualities are due to the juices of the food-plant of the larva has often been made before, but never with so much insistence as in Haase's work. He quotes a number of cases in support of his contention, and neglects those which oppose it. Haase would apparently deny to insect physiology the power to construct a protective odour or flavour, although the laboratory of an insect's body has been shown to be a marvellous workshop producing all kinds of unexpected compounds, and although the food-plants of many of the commoner of our distasteful European moths do not belong to any poisonous or acrid category. Although it is possible that the noxious or nauseous qualities may, in certain instances, be borrowed ready-made from plants, such an origin is as yet unproved; while its universality, as assumed by Haase, has been effectually disproved.

For a work of such great pretensions the want of a wide and adequate acquaintance with other writers is somewhat remarkable. Thus Dixey's memoir on the Phylogeny of the wing-markings of Vanessidæ and Argynnidæ, as well as that on the Pierinæ should have been consulted; for the author often attempts to reason upon the same lines, without having devoted any special study to the subject. In speaking of the different forms of the female of *Papilio merope* (*cenea*) he states (pp. 45, 46) that Mansell Weale *captured* a large number. In reality, the evidence supplied in support of Trimen's argument that these different forms were the females of a single species with a very different male, was of a far more satisfactory kind; for Mansell Weale *bred* all the forms as well as the male from larvæ taken upon a single tree. Furthermore, no account of this most remarkable case can be regarded as adequate without a detailed reference to Trimen's classical paper. The reference is here and on p. 104 of the most meagre and unsatisfactory kind. Again, there is no allusion to Westwood in the account of the early history of the subject, or to Gahan in the account of mimicry in Coleoptera (p. 131). In his consideration of the classification of mimicry, warning colours, &c., suggested by the present writer, the author is satisfied with the study of a second-hand account of an easily accessible work.

Again, on p. 123, Haase states that Wallace, as well as Fritz Müller, originated the explanation of resemblance between inedible species and genera. As a matter of fact, we owe to Fritz Müller alone the important suggestion that forms which resemble each other and thus combine their advertisements, so to speak, are recognised with a smaller expenditure of lives than those which possess independent advertisements, each of which requires to be learnt separately. The fact of such resemblance was first recognised by Bates, but its explanation remained a difficulty under the theory of mimicry which we received from him. Wallace freely acknowledged the debt which we owe to Fritz Müller, and at once saw the great and far-reaching importance of the new suggestion. One great fault of the present work is the failure to recognise this importance, and the attempt to explain nearly all cases on the lines of Bates' theory of specially protected model and defenceless mimic, instead of constantly introducing the useful conception of resemblance for mutual advantage between specially protected species and groups.

Thus, to take but a single example, the treatment of the resemblances of the Erycinidæ (pp. 61, 62), as well as that of some of the Pierine genera, would have received much light from the Müllerian standpoint.

On p. 134 the distinction between protective and aggressive mimicry is ascribed to the present writer, although it was made by many writers long before he contributed anything to the subject. Having made this error, Haase goes on to criticise the cases included under the latter term, stating that "the disguise itself always serves only as a means of protection, and never as a weapon of attack, even when borne by the aggressors." He then proceeds to destroy his own criticism by citing several cases (p. 135) in which he maintains that the resemblance does act as a weapon of attack. It is to be hoped that the translator is to some extent responsible for this tissue of mistake and self-contradiction. At the moment of writing, access to the German original is impossible.

There are a number of errors in the systematic part of the work which we should hardly expect to see. Thus the name *Hypolimnas bolina* (L.) is given when *H. misippus* (L.) is intended (p. 41), and the appearance of the type form is wrongly ascribed to the var. *inaria* (Cr.), although this may be a mistake of the translator. In Plate xi. (Fig. 76) an *Anthomyza* is described as a *Hyelosia*, and in the same plate an undoubted representation of *Methona confusa* (Butl.) in Fig. 78, is stated to be *Thyridia psidii* of Linnæus, the author being careful to add the words "not *Methona*" after the generic name. There has been much confusion between these two closely convergent, although in reality widely different species—so much so indeed that even Bates was deceived—but the account given by Godman and Salvin in the "Biologia" places the matter on a secure basis, and clearly shows that the Linnean species is *Thyridia psidii*, possessing white spots on the black border of the hind wing. The latter species is also distinguished by a small reddish spot at the base of the fore wing; and both these characteristics being absent from Fig. 78, we can only conclude that it represents the species of *Methona* from which they are also absent. A very unaccountable error is the positive statement (p. 145, *note*) that there are no "unmistakably mimetic species" among the Lepidoptera of Madagascar. The author must surely have been aware of the occurrence of *Hypolimnas misippus* (L.) in that island. In the same note the impression is conveyed that there is a widespread belief that isolation, as in islands, rather than the keener competition of continental areas, favours mimetic modification; and Haase apparently takes some credit to himself in supporting the opposite view. But the ancestral character of island faunas in relation to mimicry was recognised long before the appearance of Haase's work, and has never been seriously disputed.

Another obvious error occurs on pp. 147, 148, where the resemblance of the *imagos* and not the *larvæ*, as

stated, of *Calocampa exoleta*, &c., to sticks, is intended. One is at a loss to understand why some ancestral time at which Haase imagined that food was especially scarce, and the enemies of insects especially keen, should be spoken of as a "Palæolithic Period" (p. 118).

At the end of the volume the author contributes a section, entitled "Mimicry a form of protective adaptation to the environment" (pp. 145–151). In these pages he treats, in a very inadequate manner, of protective resemblances in general. The important and widespread cases of variable colour resemblances he does not even mention. The attempt is made to distinguish between protective resemblance and mimicry on the ground that the latter is an imitation of moving objects, the former of motionless ones. This distinction, which has been drawn before, seems to the present writer to be unreal, and, so far as it holds, to be of little importance as a basis for classification. There are many examples of the protective resemblance of moving objects—butterflies and moths which resemble leaves whirled along by the wind; larvæ and cocoons which resemble sticks, &c., swinging by a thread. The essential distinction lies in the fact that in protective resemblance the model is of no interest to the enemies of the imitator, while in protective mimicry the model is dreaded or disliked by the enemies; the effect of protective resemblance is concealment; the effect of protective mimicry, conspicuousness.

In this section the wonderful resemblance of butterflies of the genus *Kallima* to dead leaves is briefly discussed, and the author concludes (p. 147) that

"the extraordinarily manifold variations among *Kallima*, &c., show, not only that these so perfect resemblances of withered leaves, and often of those covered with rust-fungus or partially eaten by larvæ of *Agromyza*, are the highest development of mimicry of leaves, but they also indicate that these are the youngest forms, and are still under the influence of natural selection, which will gradually obliterate that which is less fitting."

It is, of course, very improbable that a species which has attained the highest development in any character could still remain in the formative stage as regards the very same character. As a matter of fact, the "extraordinarily manifold variations" of *Kallima* are not the ordinary individual differences upon which natural selection acts, but rather certain varied forms into which the species has been thrown by natural selection, causing it to resemble not one, but many of the appearances presented by dead leaves, and thus conducing towards its protection. This high product of selective action has been mistaken by Haase for the mere material for selection to begin its work upon.

There are some excellent pieces of work and interesting suggestive inferences to be found in the memoir—not to be compared to the great hypotheses connected with the names of Bates, Wallace, and Fritz Müller, but valuable additions to the subordinate parts and details of the subject.

Of this kind is the discussion on mimicry in the *Papilioninæ* (pp. 80–95), to which Haase has given special attention, and which forms the subject of Part i. of his work, as yet untranslated into English. In this section he produces evidence that the species of *Papilio* which are especially mimicked by others belong to the genus *Pharmacophagus*, and, as he thinks, derive their qualities from the poisonous or acrid larval food.

The contention (p. 97) that specially protected butterflies but rarely avail themselves of a distinct and markedly conspicuous "warning colour," that "among the *Neotropinæ* in general the wing-colouring, with its brilliant yellow, rusty-brown and black, is more beautiful than unpleasant," must be admitted to be true; the conclusion was, in fact, stated in 1890 by the present writer, who also pointed out that a conspicuous appearance is nevertheless attained because "the colours spread on the parts which are exposed during rest, and the flight becomes sluggish, so that they are displayed as completely as possible" ("Colours of Animals," Lond., 1890, p. 191).

On p. 106 we meet with an interesting case (that of four white spots on the outer margin of the hind wing of the female var. *protogenia* of *Elymnias undularis*, Dru.), in which it is argued with force that changes caused by reversion to an older type of marking have been made use of to aid a mimetic resemblance. In a note on the same page, Haase brings forward *Cethosia cyane*, Dru., as a unique example of a closer resemblance on the part of the male than the female to another specially defended insect—*Danais chrysippus*. He makes the very probable suggestion that the *Cethosia* is also itself specially defended.

Interspersed with much almost worthless speculation there is a great deal that is suggestive and valuable in the analysis of the various patterns of those *Neotropinæ* which are resembled by other butterflies, including many belonging to different sections of the group itself (pp. 116, 117). The various tables embody an immense amount of careful comparison and the examination of a vast number of specimens; they will prove of the highest value to future workers. E. B. P.

(To be continued.)

A DEVONSHIRE GEOLOGIST.

A Memoir of William Pengelly, of Torquay, F.R.S., Geologist, with a Selection from his Correspondence. Edited by his daughter, Hester Pengelly. With a summary of his scientific work, by the Rev. Prof. Bonney, F.R.S. 8vo. Pp. xi + 341; with portrait and 10 illustrations. (London: John Murray, 1897.)

THE story of William Pengelly is one of the pursuit of knowledge under difficulties, and of the achievement by the hero of an honoured place amongst those who have rendered distinguished service to science. Many of his paternal ancestors were sailors, and his father was captain of a small coasting vessel, in which his son William accompanied him, after receiving an elementary education at East Looe in Cornwall. For four years the lad was engaged in a seafaring life, but in 1828, at the age of sixteen, and at the earnest desire of his mother, he returned to his native village, and was occupied for a few years in active manual labour. He had, however, developed a passion for learning, and every hour that could be spared, was devoted to the acquisition of knowledge, and more especially of mathematics. Having so far prepared himself, after severe

study and under great privations, for more congenial labours, he removed to Torquay and opened a small day-school. Here he met with good success, which rapidly increased as the years passed by.

His earliest geological lesson had been learned at Lyme Regis when, as a sailor boy, he had been weather-bound on the Dorset coast, and had observed a fine ammonite. Later on the reading of a chapter on geology in a work published by the brothers Chambers, gave him his first insight into the objects of the science, and led him to devote attention to the subject. Thus, when he went to London in 1843, he was interested in visiting the British Museum, the Royal College of Surgeons, and the Museum of Economic Geology (as it was then called) at Craig's Court. He had some difficulty in finding the last-named museum.

Torquay has always been a locality of great interest to the geologist, and when Pengelly commenced his labours it was not long after the founding of the Devonian system by Sedgwick and Murchison, aided by Lonsdale. Moreover, De la Beche and Godwin-Austen had published their important researches on South Devon, and McEnery had brought into notice the interest attaching to the local bone-caves. No wonder that Pengelly, when once his ardour had been kindled, started to explore the district with vigour and enthusiasm.

Many little adventures and anecdotes are recorded with reference to his geological expeditions. On one occasion at a wayside inn, where he had taken a seat on the kitchen settle, Pengelly answered some inquiries addressed to him by three labourers, and finally entertained them to such good effect on the subject of stone-breaking, that the landlord became keenly interested. Seeking an interview next morning with Pengelly, he thus expressed himself:

"I hope no offence, sir: but ef you'd stop 'ere for a foo days, or a week, and talk to the men in the evenin's, you shud be welcome to meat, drink, washing, and lodging free gratis. I'm sure lots o' men wud come an' hear 'ee, and I should zell an uncommon zight o' beer."

In 1855 Pengelly went, for the first time in London, to an evening meeting of the Geological Society. In a letter to his wife he says:

"There were probably about forty persons present, which I believe is considered a good attendance. We were rather late, and found on our arrival that a paper was being read descriptive of Mauna Loa, the volcano in Owhyhee. At its close, Austen, a well-known geologist, and who once lived at East Ogwell, read a paper on the 'Probability of coal existing at workable depths near London.' . . . A discussion followed the paper, in which the author was by no means spared, as the various speakers expressed themselves freely."

What seems remarkable to us is the small attendance at the reading of this important paper by Godwin-Austen, and the fact that it was given second place at the meeting! Next year Pengelly attended another meeting of the Geological Society, when papers were read by Carrick Moore and Babbage. He says, "It was a magnificent meeting, and made me wish for a town residence."

Pengelly first attended the British Association in 1856, at Cheltenham, and he was present at all subsequent meetings up to 1889, with the exception of that held at Montreal in 1884.

In 1858 his detailed researches on the caverns of Devonshire may be said to have commenced. In that year the Brixham Bone-cavern was discovered, and the investigation was undertaken by the Royal and Geological Societies; a committee being appointed by the latter body, and the exploration being placed under the superintendence of Mr. (afterwards Sir Joseph) Prestwich and Mr. Pengelly. The bulk of the work naturally fell to Pengelly. It was long before the results of this investigation were issued. The delay, indeed, was aggravating, for it was not until 1873 that the full account was published.

Meanwhile Pengelly became engaged in a systematic examination of the lignites and clays of Bovey Tracey, in conjunction with Dr. Oswald Heer, who undertook the determination of the plant-remains. This important work was executed at the expense of the Baroness Burdett-Coutts, and the results were published in 1862. The age of the deposit was regarded by Heer as Miocene, but it has since been shown by Mr. Starkie Gardner to be Eocene.

In 1864 the first steps were taken to secure a systematic exploration of Kent's Hole, Torquay; and, aided by grants from the British Association, the work was carried out by Pengelly, who for more than fifteen years devoted himself with never-flagging energy to the task. During these years he annually reported progress at the meetings of the British Association, and his discourses on these occasions formed an attractive feature in the proceedings of Section C. Here, as elsewhere in all his lectures, he contrived to blend his science with a considerable amount of humour, while his expositions were both clear and spirited.

With regard to the exploration of Kent's Hole, Prof. Bonney rightly observes that "it was the most complete and systematic investigation of a cavern which had ever been undertaken." The time and labour, the care and patience, exhibited by Pengelly, and the precision with which he noted every fact, were extraordinary, but thoroughly characteristic of the man. His very full reports will ever remain as a monument of these labours. He had intended to publish a separate book on Kent's Cavern; but, considering that all particulars have been given in his many papers, the abandonment of this task need not seriously be regretted.

This outline of his principal work affords but a meagre idea of the activity of the man. He not only spent a good deal of time in lecturing in many provincial towns, but devoted much energy to local institutions in Torquay. The organic remains from various formations in Devonshire were eagerly sought for, and a fine collection of Devonian fossils which he had gathered together was presented to the Oxford Museum by the Baroness Burdett-Coutts in 1860.

His main efforts were always directed to the geological questions relating to Devon and Cornwall. He was master of all the literature, and many of his contributions were most useful summaries of knowledge on particular subjects. Curiously enough, but little is said in this volume of his fellow-workers in Devonshire. Dr. Harvey B. Holl, who, after Godwin-Austen, published a detailed account of the geology of South Devon, is not mentioned. Nor is much said of G. W. Ormerod nor of A. Cham-

pernowne, the latter of whom had laboured more assiduously than any previous worker at the intimate structure of parts of South Devon. More frequent references are made to William Vicary, who happily survives, and whose grand collection has done so much to illustrate the life-history of the rocks of Devonshire; and there are several references to John Edward Lee, though not to his collection of Devonian fossils, perhaps the finest of its kind as regards South Devon. Such omissions may not be deemed of great importance, but to one not familiar with the subject the book is apt to convey the notion that Pengelly was almost the sole worker, in his time, on Devonshire geology.

A great portion of the volume is taken up with letters from Pengelly to various members of his family, giving interesting accounts of his journeys and lectures, and of the many men of science and others whom he met; and there are numerous extracts from letters of Lyell and others addressed to Pengelly. The fame of Kent's Cavern brought many an illustrious visitor to Torquay, and although Pengelly's time was a good deal taken up in describing the cavern and its contents, he was naturally gratified at the interest manifested. In society he was always a genial companion, full of fun, and notoriously full of puns; so much so indeed that in 1862, at the first meeting of the Devonshire Association, which he was mainly instrumental in founding, he was christened Mr. *Pun*gelly by the President, Sir John Bowring.

Prof. Bonney, in a concluding chapter, has given a capital account of the scientific work of Pengelly; and appended to it is a list of his papers, apparently compiled from the Royal Society "Catalogue of Scientific Papers." Unfortunately these are not enumerated in strict chronological order, nor is the list complete. It would have been well to make it so, for it would have been an appropriate record of Pengelly's many-sided labours. One of his elaborate papers, published in the *Transactions* of the Devonshire Association (vol. v.), dealt with "The signs of the hotels, taverns, inns, wine and spirit vaults, and beershops in Devonshire"—a subject that should not be without interest to the field-geologist.

Those who were personally acquainted with Mr. Pengelly will read this work with especial interest, including the accounts of many minor circumstances that otherwise may appear somewhat trivial and unnecessary. When, however, we remember that the work has been edited by the loving hand of a daughter, we may well pardon any excess of zeal, and thank her for having given so excellent a biography of one who laboured manfully, enthusiastically, and successfully in the cause of science.

H. B. W.

MEXICAN ARCHÆOLOGY.

Archeological Studies among the Ancient Cities of Mexico. Part ii. By W. H. Holmes. Pp. 200. (Chicago, 1897.)

THE second part of Mr. Holmes' work on the ancient cities of Mexico has this year appeared, and completes the first part of a series of anthropological publications to be produced under the auspices of the Field Columbian Museum at Chicago. This work, extending as it does to over 300 pp. and containing numerous plans, sketch-maps, drawings and photographic reproductions, has been conceived on a somewhat more ambitious scale than previous publications of the Field Columbian Museum. It is evident at a glance that the greatest pains have been taken in the preparation of the plans and drawings, while the numerous papers Mr. Holmes has already contributed to various scientific journals are a sufficient guarantee of his competence to undertake a survey of one or more of the cities of ancient Mexico. In this field of archæological research there are already many patient workers who devote much time to the excavation and survey of the ruins, but there is no lack of material for study, and many sites still remain comparatively untouched. We must admit, however, that the two parts before us are a little disappointing. From the obvious care expended on them we were prepared to welcome them as a contribution of the first importance to Mexican archæology, but on perusal they do not quite justify our expectations. Let us hasten to add that this is due to no fault of the author, but is a necessary consequence of the plan and nature of the expedition of which the volumes are a record.

Mr. Holmes' studies among these ancient sites were undertaken in the spring of 1895, when he spent three months travelling in these regions with Mr. A. V. Armour, of Chicago, and other friends. Botany, geology, anthropology and natural history were impartially studied by the party, and, as Mr. Holmes remarks in his preface, he himself as "Curator of Anthropology" in the Field Columbian Museum, "was expected to examine and describe such archeologic remains as happened to be encountered during the journey." It must not, however, be supposed that the book is merely the record of a pleasure trip. The localities visited are dealt with systematically, but in every case too little time was given to the examination and measurement of the ruins. The first part of the trip was devoted to the monuments of Yucatan, when the islands of Contoy, Mugeres, Cancun and Cozumel, and the mainland opposite them, were examined in less than two weeks, during which period the party went as far south as Tuloom, where they did not land, but Mr. Holmes sketched the ruins from the sea. In the interior of Yucatan the remains at Tikul, Uxmal, Izamal and Chichen-Itza were also examined in less than a fortnight. The first part o the book dealt with these places, but it will be obvious that so little time having been spent at the actual ruins, Mr. Holmes' notes were necessarily superficial. He thereby lays himself open to correction by more systematic explorers than himself, and, as a matter of fact, Mr. Alfred P. Maudslay, who in 1889 encamped for five months at Chichen-Itza, which Mr. Holmes and his party in 1895 did in a week, has already pointed out in the columns of NATURE (vol. liv. pp. 274*ff.*) several inaccuracies in his observations. The second part of the work, which has just appeared, deals with the monuments of Chiapas, Oaxaca, and the Valley of Mexico, and though larger in bulk than its predecessor, represents the result of observations made in an even shorter period, four days being spent on the ruins of Palenque, a week at Mitla, a day on Monte Alban, while from Mexico two brief excursions were made to San

Juan Teotihuacan. It is needless to point out that this publication could not have been compiled had the places never been surveyed and described by other explorers. Mr. Holmes frankly admits that his work is no more than a sketch of the sites he visited "seen at a passing glance"; but even regarded merely as an introduction to the study of Mexican archæology, its value to the student would have been much increased by the inclusion of references to the extensive literature on the subject, and by a discussion of the work accomplished by previous explorers and archæologists.

OUR BOOK SHELF.

Manuale del Chimico e dell' Industriale. By Prof. Dr. Luigi Gabba. Pp. xvi + 442. (Milan: Ulrico Hoepli, 1898.)

La Fabbricazione dell' Acido Solforico, dell' Acido Nitrico, del Solfato Sodico, dell' Acido Muriatico. By Dr. V. Vender. Pp. v + 312. (Milan: Ulrico Hoepli, 1898.)

Leghe Metalliche ed Amalgame. By I. Ghersi. Pp. xii + 431. (Milan: Ulrico Hoepli, 1898.)

THE three volumes, the titles of which are given above, belong to an extensive series of manuals published by the firm of Hoepli, Milan. More than five hundred of these Manuali Hoepli have now been published, covering a variety of subjects in science, letters, arts, and industries.

Prof. Gabba's volume is a collection of tables of physical and chemical data, and of analytical processes, for the use of analytical and technical chemists, directors of chemical works, students of chemistry, and others. The tables and the descriptions of methods of detecting various substances, and of carrying out a complete analysis or assay, will be found very serviceable to all technical chemists. The volume contains a mass of physical and chemical data, and it will prove as useful to analysts as engineering pocket-books are to engineers.

Dr. V. Vender's work on the manufacture of sulphuric acid, nitric acid, and hydrochloric acid, presents in a concise form the essential facts of these great chemical industries. In the case of each product, the substances employed in its manufacture, the general principle of the manufacture, the theory of the various processes, the details of construction of the plants in use, and methods of analysing the products, are described. The book is instructively illustrated; and though the text is in Italian, English chemists will find that they can read it by occasional reference to a dictionary.

In the third of Hoepli's Manuals referred to at the head of this notice, Signore Ghersi provides metallurgists with a handy book on metallic alloys and amalgams. The volume opens with a description of alloys in general, and then deals in succession with binary alloys, alloys of aluminium with common metals, nickel alloys, amalgams, alloys of gold, silver, and platinum, alloys for coinage and medals, bronzes, brass, ternary and quaternary alloys, Delta metal, fusible alloys, alloys which simulate various metals, and solders. There is an appendix containing useful tables of physical and chemical data referring to alloys, a long list of works cited, and a good index. The author frequently refers to recent investigations of metallurgists in various parts of the world, and his book does credit to him and to the scientific spirit in Italy.

Lectures on Quaternions. Part i. Introductory. By S. Kimura, Sendai, Japan.

WE are unable to read this treatise, because it is printed in Japanese. The mathematical formulæ and woodcuts show that the author is introducing his students to those elementary geometrical (curve and surface) illustrations of the vector calculus (mainly vector addition and differentials) which may be taken up without any knowledge of a quaternion. The characters are printed in horizontal rows instead of the usual vertical columns, and this might be taken as the text for a sermon on the modern changes in Japan. The concession is necessary if a student is to read mathematical formulæ with ease, yet it is one which need not alarm the scholars, and by making it the author takes away an objection to the use of Japanese characters, and so keeps his reader in touch with Japanese literature. Every Japanese reader of such a treatise is well acquainted with English, and if the teaching of mathematical science were to be considered by itself, all such books might just as well be printed in English. But it is well known to all who have studied the Japanese that they are not merely studying our commercial and military and scientific ideas, but how they may assimilate these ideas without undue hurt to their own old civilisation and developed instincts and fine moral character, which seem to them, and indeed to some of us, of a very much higher order than what we find in Europe. Well, the vector calculus can do little harm to anybody; but when Part ii. is published, and the author introduces his quarternions, he may be glad that the old scholars who protect the morals of his country are unable to understand what he is writing about. J. P.

Lehrbuch der Erdkunde für höhere Schulen. By Dr. Willi Ule. I. Theil (Für die unteren Classen). Pp. viii + 176. (Leipzig: G. Freitag, 1897.)

THIS is an excellent reading-book for children, but as it is printed in the German language, it will not be found very useful this side of the Channel. Written in a very simple manner, and dealing only with fundamental ideas, the author describes clearly and concisely the main physical features of the earth—such as mountains, plains, continents, races, &c. Each of the different countries is generally described, and typical illustrations are inserted here and there. Several paragraphs are also devoted to brief general descriptions of the weather, climates, elementary astronomical phenomena, map-drawing, &c. The author has succeeded in bringing together in a methodical and natural sequence a great amount of information which the children will read with delight. Names and numbers have been suppressed as far as possible in the text, these being added in tabular form at the end of each section, more for the use of the teachers than for the readers.

The Great Meteoric Shower of November. By W. F. Denning, F.R.A.S. Pp. 52. (London: Taylor and Francis, 1897.)

UPON the subject of meteor-observation, Mr. Denning teaches "as one having authority, and not as the scribes." This pamphlet, reprinted from the *Observatory*, furnishes meteoric observers with a number of interesting facts as to past November showers of Leonids, and prospects of observations between now and 1905. Mr. Denning deals in succession with the position of the Leonid radiant, the character of the radiant, the visible aspect of the individual Leonids, the real paths of the meteors in our atmosphere, minor meteor showers visible at the Leonid epoch, expected phenomena at the ensuing return, the observations required, and the November shower from Biela's comet. Every astronomical observer should possess a copy of the pamphlet, for the perusal of it will show him exactly what points require attention, and will thus increase the value of his observations.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Bee's Movements in a Room.

THE following was communicated to me by a friend of mine, Mr. E. W. Winstanley, of Trinity College, Cambridge, and, as it may have some value respecting the relations of insects to flowers, I think it worth putting on record. The observations were written down on the day after the occurrence, when he related to me the facts, and I reproduce them here in his own words:—

"Sitting reading in my room (15 Jesus Lane) by the open window, about noon, October 21—a sunny day—I became conscious of a buzzing sound, and, on looking up, found it due to the entrance of a bee. Noticing that certain objects seemed to arrest the insect's attention, I paid special heed to its movements. It first went across to the pictures on the opposite wall, following them round the room, and hovering a short time close to each of the coloured ones, then passing out of the door, which was wide open; returning, after a few seconds, it flew straight to the gas-shades, which, two in number, are situated one on each side of the mantelpiece; it lingered over the top of one, and then passed on to the other, and repeated this movement. It now took a second tour of the pictures, and after stopping a moment or two near one of the brass knobs of the curtain-pole, came again to the gas-shades and made a closer investigation of them, both by hovering over the top and by entering at the bottom around the gas-burners. It then visited in succession four ornaments on the mantel-mirror, drew near once more to the large central coloured picture, made a second exit by the door, coming back almost immediately, and, after dwelling near the two small coloured pictures for the third time, flew straight out of the window.

"It never actually alighted anywhere, remaining near the objects by the rapid quiver of its wings. The whole visit the bee paid me occupied probably five minutes or less. Although I did not examine it closely, I considered it to be a hive and not a humble bee."

The special features to notice in the above are the systematic way the bee flew about, and the nature of the objects which attracted its attention.

Any one on surveying the room would admit, I think, that the gas-shades and the pictures are the most brightly coloured things in it.

The gas-shades are semi-opaque, lily-shaped, and tinted from yellow to bright pink upwards; in fact, they resemble very large gamopetalous flowers (corollas).

The pictures in the room numbered seven, consisting of a large frame enclosing five photochrome views, of two small photochromes, and four photogravures. My friend says it was distinctly the coloured ones that attracted the bee, giving the other ones a mere glance, as it were. The photochromes are vividly coloured, blue predominating.

The remaining objects visited, the ornaments, are not striking or large, but have flowers painted on them on a white ground, mostly resembling blue forget-me-nots. My friend was somewhat astonished at the bee regarding these, as he was not aware, till he looked, that the vases were decorated thus. He is not a botanical student, and has no bias towards any theory of the flower; it was the methodical way the bee went about the room that arrested his attention. It is mainly owing to this fact that I thought it worth while to make his observations known. Recently some observers have put forward reasons for considering that the colour of the flower exerts little attraction towards insects, and that it is chiefly the odour. The above piece of information favours decidedly colour attraction. There was no perception of odour, or any flowers or plants present in the room at the time.

To my mind it seems rational to assume that colour and odour may play somewhat equal attractions, the scent serving to bring bees from a distance, and the colour helping to guide them directly to the honey. A bee becoming accustomed to associate nectar with conspicuously coloured objects, might thus learn to visit flowers wholly from colour-sensation, and, not having sufficient discriminating power, visit other brightly-coloured things as well.

J. PARKIN.

Trinity College, Cambridge, October 23.

A Test for Divisibility.

MAY I venture to supply a long-felt want amongst arithmeticians, viz. a general test of divisibility?

Let N be any integral number, and δ any divisor, then

$$\begin{aligned} N &= a + 10b + 10^2c + \&c. \\ &= a + b(\delta q + r) + c(\delta q + r)^2 + \&c. \\ &= \delta Q + a + br + cr^2 + \&c. \\ &= \delta Q + a + b(\delta q_1 + r_1) + c(\delta q_2 + r_2) + \&c. \\ &= \delta Q + \delta Q_1 + N_1 \\ &= \delta(Q + Q_1) + N_1. \end{aligned}$$

Here N_1 is the least general substitute for N, and is of the form

$$a + br_1 + cr_2 + dr_3 + \&c.$$

where the number of values of r_1, r_2 &c. cannot exceed $\delta - 1$, but may be much fewer, and constitute a recurring series found from

$$\frac{10^n}{\delta}, \text{ where } n = 1, 2, 3, 4 \ \&c.$$

$$\begin{aligned} \text{Let } \delta &= 2, 5, \text{ then } N_1 = a \\ &= 4, \quad = a + 2b \\ &= 8, \quad = a + 2b + 4c \\ &= 16, \quad = a + 10b + 4c + 8d \\ &= 3, 9, \quad = a + b + c + \&c. \\ &= 7, \quad \left.\begin{array}{l} = a + 3b + 2c + 6d + 4e + 5f \\ + g + 3h + 2i + 6j + 4k + \&c. \end{array}\right\} \\ &= 37, \quad \left.\begin{array}{l} = a + 10b + 26c \\ + d + 10e + 26f + \&c. \end{array}\right\} \\ &= 11, \quad = a + 10b + c + 10d + \&c. \end{aligned}$$

and so on.

The practical importance of this general test must primarily depend on the brevity of the recurring period of r_n, but in special cases this objection may be removed.

Thus when $\delta = 11$, if $N_1 \div \delta = 11q$ we have

$$\begin{aligned} N_1 &= (a + c + \&c.) + 10(b + d + \&c.) \\ &= S \times 10S_1 = 11q. \end{aligned}$$

But $S - q = 10(q - S_1)$
where $(S - q) \div 10 = q - S = q_1$ suppose;
also $S_1 = (11q - S) \div 10$;

$$\therefore \ S - S_1 = 11\left(\frac{S-q}{10}\right) = 11q_1.$$

That is, the difference of the sums of the alternate series of digits is divisible by 11 if N or N_1 be so divisible. This result may be applied thus: Let a_3, b_3, c_3 &c. denote triple periods, and $\delta = 1001$, then

$$\begin{aligned} N_1 &= a_3 + 10^3b_3 + c_3 + 10^3d_3 + \&c. \\ &= (a_3 + c_3 + \&c.) + 10^3(b_3 + d_3 + \&c.) \\ &= S + 10^3S_1 \text{ which may be changed to} \\ &\quad S - S_1. \end{aligned}$$

Thus $S - S_1$ is a test for divisibility by 7, 11, 13, 77, 91, 143, 1001.

Again, if a_4, b_4, c_4 &c. denote quadruple periods and $\delta = 10{,}001$, then

$$N_1 = a_4 + 10^4b_4 + c_4 + \&c. = S - S_1$$

and is a test for $\delta = 73, 137, 10001$.

Again, if a_6, b_6, c_6 &c. denote sextuple periods and $\delta = 1{,}000{,}001$, then

$N_1 = a_6 + 10^6b_6 + c_6 + \&c. = S - S_1$ and is a test for $\delta = 101$; 9901.

As examples take

(1) $N = 807{,}929{,}122$; $\delta = 7, 11, 13, 143, 77, 91$;
$S - S_1 = 122 + 807 - 929 = 0$.
$\therefore$ the proposed number is divisible by δ.
(2) $N = 67, 3558, 3491$; $\delta = 73, 137$.
$S - S_1 = 3491 + 67 - 3558 = 0$.
(3) $N = 360, 4536, 7388$; $\delta = 73$.
$S - S_1 = 7748 - 4536 = 3212 = 73 \times 44$.
(4) $N = 390, 9569$; $\delta = 137$.
$S - S_1 = 9179 = 137 \times 67$.
(5) $N = 585622, 677027$; $\delta = 101$.
$S - S_1 = 91405 = 905 \times 101$.
(6) $N = 954221, 304387$; $\delta = 101$.
$S - S_1 = 649834 = 6434 \times 101$.

When the periods consist of similar groups, as

222, 222;
123, 123;
333, 777, 444;
333555, 333555;
5174, 1399, 1399, 5174;

divisibility by the formula $S - S_1$ may be determined by inspection, and this conclusion will not be modified by like permutations of each group. Thus 123123, 312312, 132132 &c. are each divisible by 7, 11, 13, 91, 143 &c.

Lastly, since r_n changes with every value of δ, no general formula for the determination of primes can exist.

HENRY T. BURGESS.

Tarporley, West Norwood, October 16.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.[1]

IT is difficult to know how best to review a volume consisting of such varied matter as the Report of the Proceedings of an Educational Congress. Even when restricted to technical education, the subjects that may be legitimately discussed are very numerous; and with the constant widening of the definition, it is not easy to exclude any branch of knowledge, as outside the field of inquiry. After reading very carefully the closely-printed volume of nearly 300 pages, which includes the papers *in extenso*, and a summary of the discussions, we must own to some feeling of disappointment at the poverty of the results. Several of the writers and speakers are men of knowledge and experience, who write and speak with authority on their respective subjects; but, nevertheless, the volume before us adds little to what was previously known, and we look in vain through its pages for any new light to guide us in solving problems that are still imperfectly understood. The papers are, of course, of unequal merit, and we propose briefly to call attention to a few only, selecting rather those the authors of which show themselves abreast of the difficulties to be overcome.

The Congress was the fourth of its kind, the two previous meetings having been held in Bordeaux, in the years 1886 and 1895, and the first in Brussels in 1880. The latest Congress, held in London, was organised by the Society of Arts—a society which has always shown a deep and very active interest in technical education. It occupied four days from June 15, when M. Leo Saignat and the Duke of Devonshire delivered short introductory addresses, till Friday, June 18, when it was brought to a close by a few words of thanks from the chairman, Sir Owen Tudor Burne, to those who had assisted.

It is not easy to correctly group the contributions under separate headings. Several papers were descriptive of the methods and conditions of education in the countries and districts with which the authors were familiar. Some few treated of educational problems, and these were perhaps of widest interest. The vexed question of the organisation of instruction and of examinations was very fully discussed; a whole morning was devoted to papers bearing upon the teaching of domestic science; and a special feature of the Congress was the prominence given to the subject of commercial education.

Among the papers dealing with educational method, those on the teaching of chemistry were certainly the most informing. The character of the chemical teaching best adapted to the requirements of persons actually engaged in industrial pursuits, and also to school children preparing for such pursuits, had recently been the subject of a thoughtful report, prepared by a Committee specially appointed by the Technical Education Board of the London County Council. This report had been widely circulated, and both Dr. Witt, of Berlin, and Dr. Lunge, of Zürich, referred to it in their communications to the Congress. It is doubtful, however, whether either of these professors fully appreciated the problem, as it presents itself to organisers of evening classes in this country. Neither in Germany nor in Switzerland is there anything approaching to the teaching of technological chemistry, by means of evening lectures, to artisans. When Dr. Witt states, in his paper on the "Relation existing between the teaching of pure chemistry and applied chemistry," that he "cannot admit any fundamental difference in the methods of research," every one will agree with him; but when he says, "we want no schools for producing specialists," it may be reasonably thought that his generalisation is too far-reaching. There are successful dyeing schools in all parts of Europe, and he, himself, admits that "Dyeing, calico-printing, and paper-making are . . . industries which may rightly claim the necessity of some special instruction in the methods of manipulation," even if no other industries have like claims. Although Dr. Lunge, who is essentially a technologist, puts in a plea for the study of applied chemistry, his views do not differ essentially from those of Dr. Witt. He is at one with other chemical teachers in recognising the importance of training in the methods of research for all students. He says very truly: "Nothing in these times of ours is likely to turn out a first-class chemist, worthy of being later on put in charge of a large factory, who has not tried his hand at original research." Dr. Lunge insists, however, on the advantages of specialised training, and refers to the demand of Dr. Böttinger, head of a chemical factory, having under him a staff of more than one hundred chemists, for the establishment of more professorships of technological chemistry. It is, nevertheless, clear that the difference between the training in pure and applied chemistry which Dr. Lunge has in mind, consists mainly in the addition to the curriculum of technological students of a course of instruction in engineering, in order that they may advance beyond the position, to use his own words, of "testing slaves," to understand something of the processes of manufacture on a commercial scale. Dr. Lunge shares with most German chemists the opinion, that the knowledge of chemistry and technology that can be imparted to adults in night classes is useless from the manufacturer's point of view. He says: "I do not even think that apart from isolated exceptions, such knowledge is of much good to the foreman, whose duty it is to carry out instructions, and to see that the men do their work as prescribed by the staff." And, more definitely, he tells us, that "in Germany, even in those factories where the work is carried on with the greatest chemical refinement, the foreman and ordinary workmen are neither required nor even desired to know anything of chemistry." Dr. Lunge, in this statement, is, of course, referring to large chemical works in which there is a complete system of division of labour and sectional work, and where every difficulty, as it occurs, is at once submitted to some member of the large staff of chemists employed. But it is now generally admitted that there are many small trades in which a knowledge of chemistry is useful to the ordinary workman, and that the training, even when it proceeds from the process to the principle, may be made educationally valuable in supplementing the still imperfect, and too brief discipline of the elementary school. Prof. Armstrong's characteristic paper, indirectly bearing upon this subject, entitled "Heuristic instruction in physical science," was intended to show that the aim of sound science teaching should be to put learners in the attitude of discoverers; and there is no doubt that if such teaching were more general, the necessity for specialised instruction would be lessened, and a great part of the technical teaching of evening students might be remodelled. Dr. Armstrong scarcely did justice, however,

[1] Report of Proceedings of the Fourth Meeting, held in London, June 1897.

to the good work now carried on in some of the London polytechnic institutions, which do not, as a fact, give any undue prominence in their teaching to the requirements of the Science and Art Department's examinations. Every one, however, will agree with him, that in the organisation of education some machinery must be found, whereby those, in whom the control of education is vested, are brought into contact "with those who are actively engaged in improving the methods of teaching, *i.e.* in educational research."

Of the papers dealing more particularly with technical education in relation to trade subjects, that of Mr. Sidney Wells, on the qualification of teachers, will be read with most interest. He recommends the attachment to trade classes, of student-teachers who would be required to follow a course of instruction covering two or three years. The students would be selected from the members of separate trades, and would be remunerated by scholarships for the loss incurred during the period of their training. The means of providing a suitable training for trade teachers is a serious question that must be faced before long. In many of our trade classes, as now conducted, there is a lamentable waste of energy and money owing to the want of previous education of those who *faute de mieux* are appointed as instructors. A paper on "Theory and practice in trade teaching" deals with the same question from another point of view, showing the difficulties inherent in the teaching of trade subjects, as regards both the instruction to be given in the principles of science applicable to a particular trade, and the use of tools and machinery in workshop practice. In the discussion that followed the reading of these papers, and of others bearing incidentally upon the same subject, no serious attempt was made to grapple with the real difficulties of the problem. As might have been expected, there was considerable divergence of opinion as to whether technical instruction should be limited to the section of the trade in which the student is actually engaged, or should extend beyond it—a question which is unavoidably complicated by trades-union considerations. Mr. Steward, of the Central School of Arts and Crafts, in reference to the gold and silver trades, expressed his opposition to the system prevailing at the Vittoria Street School, Birmingham, where lads are encouraged to practise in the school other branches of the trade than the one at which they daily work. On the other hand, Prof. S. P. Thompson quoted with approval a passage from a report of the Technical Education Board to the effect, that at the Crafts School every effort was made "to give students a broader view and practice of the craft in which they are engaged"; and he exemplified his meaning by suggesting that silver chasers might be required to learn some other branch of the trade, such as engraving or enamelling. No fault can be found with many of the general principles enunciated in connection with trade teaching. That "all Technical Education Boards should negotiate with trade organisations with a view to co-operation"; that "technical education means a different thing in every trade or group of trades"; and that "all teachers of technical classes should be practical craftsmen," are propositions generally admitted. But, as regards teachers, we have already seen that the qualification of practical craftsmanship is not alone sufficient, and the difficulty arises in finding, united in the same person, the combination of qualities now needed.

No educational congress could be held in England without frequent reference to the subject of examinations. Questions of organisation and control, the influence examinations exercise, or might be made to exercise, on teaching, were very fully discussed. Prof. Wertheimer, speaking as a teacher, said: "There are not a few of us who would be prepared to make the establishment of a new examination a misdemeanour, unless the examination took the place of one or more already in existence." A few good suggestions were made in the course of the discussion for the better coordination of examining bodies, but progress in this direction can scarcely be looked for until the passing of a satisfactory bill for organising secondary education.

Mr. Quintin Hogg read an interesting paper on the new polytechnics of London, and Dr. Garnett referred in detail to the efforts made by the London County Council to place the instruction given in those schools on sound educational lines. The appointment of an educational principal to each school, the insistence on practical teaching in the laboratory or workshop, the encouragement of special advanced studies suitable to each locality, and the establishment of an efficient system of inspection, are evidence of the thought and care bestowed upon the direction of these institutions. They are still, however, in an experimental stage of existence; but in the provision they afford for secondary technical instruction, particularly of that kind adapted to evening students, they serve to indicate the great progress that has been made during the last five years.

Among the descriptive papers contributed by foreign delegates, that of Herr von Deifenbach, on the system of instruction in Würtemburg, would claim first consideration, if space permitted us to enter upon this group of subjects. None of these communications, however, add much to the information already furnished in the reports of various Commissions, and in the articles on foreign schools that have appeared from time to time in these pages, and in those of other journals.

The question of commercial education was fully discussed by several speakers, including M. Siegfried, Mr. Hewins, Mr. Sidney Webb, and Mr. Organ. The cry for commercial education, when carefully defined, seldom means more than a demand for the systematic teaching of modern subjects in our secondary schools. A course of French and German intelligently taught, lessons in scientific method illustrated by laboratory work in chemistry and physics, instruction in practical mathematics with graphic exercises, and lectures on history with explanations of the growth and routes of trade would satisfy most of the requirements of those who attach value to commercial education; and schools giving such a training will probably be found in every large town, when our secondary education is fairly organised. In connection with this subject, attention may be called to a report on commercial education in Europe recently issued from the Bureau at Washington. Dr. James, the writer of the report, tells us: "There is no institution in Great Britain, which fairly deserves the name of a commercial high school. . . . England is now beginning to wake up to the necessity of this sort of education. Boards of trade, teachers' conventions, educational societies, have all begun to agitate for its introduction." And, later on, he says: "Instead of taking hold of the subject at the right end, and organising a great institution in London, which might serve as a model for such schools elsewhere, the English began their work in this field, as in many similar instances, by establishing examinations." We feel the force of this criticism; but it is a question, to be carefully considered, whether high schools of commerce, similar to our science colleges, are really needed in this country, for the training of youths between the ages of eighteen and twenty-one in the details of office work. In their papers dealing with this question, Mr. Webb and Mr. Hewins have contributed to the better apprehension of the difficulties of the subject. As pointed out by one of these writers, the highest commercial instruction must be specialised to prove useful and attractive, and it should appeal to those engaged in the particular branch of commerce to which it refers.

We cannot close this short notice of the subjects con-

sidered at the Congress without reference to the papers on domestic economy. It must be admitted that the teaching of such subjects as cookery and laundry work has been made of late years distinctly more educative, and at the same time more practically useful. Much of this improvement is undoubtedly due to the educational experiments carried out by Mr. Hugh Gordon and by Mr. Heller, under the direction of the London School Board. The results of their work may be seen in the training schools attached to some of the polytechnics, and in the classes held in other institutions. Miss Walter's paper on "Domestic science as an element in girls' education" shows the great advance that has recently been made in the treatment of this important subject, and marks the distinction, not always clearly indicated, between the teaching of domestic science and of domestic arts. For persons qualified to give instruction in the science there is an increasing demand; and in her paper, Miss Walter gives an outline of the course of training such persons should undergo, and her suggestions do not err on the side of incompleteness.

It is doubtful whether the bulky volume, the contents of which we have endeavoured to summarise, will be read by many, even of those persons who are actually engaged in the work of technical education. Such congresses, however, serve a useful purpose in bringing people together for the interchange of opinion, and in inducing a few persons to think seriously on some of the difficulties which, owing to its wide meaning and the variety of its methods, the problems of technical education undoubtedly involve.

MICROSCOPIC STUDY OF ALLOYS.

THE study of metals with the microscope proceeds apace, and is now becoming as generally pursued among metallurgists as the determination of melting points has been during the last five years. Since the appearance of Prof. Roberts-Austen's article on "Micrographic Analysis" (NATURE, vol. lii. p. 367, 1895) of iron and steel, a large amount of work has been done; but most observers still devote themselves more or less exclusively to the study of this metal, attacking unsolved problems which seem to have great industrial importance. This tendency is unfortunate from some points of view, for the complex constitution met with in that protean element makes it less easy to explain the observed appearances until, by work on simpler alloys, a better acquaintance with the whole subject has been obtained. M. Charpy is one of those who has resisted the temptation offered by the alloys of industry, and in a recent paper [1] has given some interesting results of his investigations on binary alloys which are well worth re-statement.

It is now fairly established that microscopic examination gives an immediate analysis of alloys, which is all the more valuable for differing in its results from chemical analysis, since these differences indicate the existence of definite compounds, and elucidate the structure in other ways. The immediate analysis is now made with the aid of a planimeter, as Sauveur recommended, by which the ratio of the areas occupied in the microscopic field by the various constituents can be measured. The metal or metals forming each of these constituents can often be indicated by their colour, hardness and, above all, the effects on them of various reagents, and thus a full account of the alloy can be given.

In the normal type of constitution of binary alloys, crystals of one of the metals, or of a definite compound of the two, are seen enveloped in a second constituent, which is generally the eutectic alloy, containing both elements in a very finely-divided state. The composition of the eutectic mixture remains constant, whilst the amount of isolated crystals varies with the percentage composition of the alloy. The limiting cases of a pure definite compound or metal, and of a pure eutectic mixture may be grouped with these alloys.

Eutectic alloys vary in appearance according as they have been cooled slowly or quickly. In the latter case, the surface is uniformly striated, but the crystals or crystallites are so small, that it is difficult to obtain satisfactory photographs of them. When the solidification is slow, however, the separation into lamellæ is strongly marked, especially when viewed under high powers, and this structure is highly characteristic of eutectic alloys, being easily traced in any of them whatever the metals in the alloy may be. It is well shown in Fig. 1, which represents an alloy containing silver 66 per cent., antimony 34 per cent., magnified 500 times; the metal has been treated with sulphuretted hydrogen, which has blackened the silver and left the antimony unchanged.

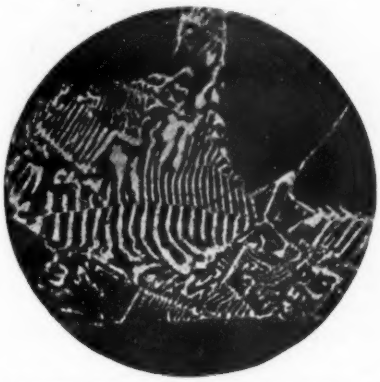

FIG. 1.—Alloy of silver, 66 per cent.; antimony, 34 per cent.

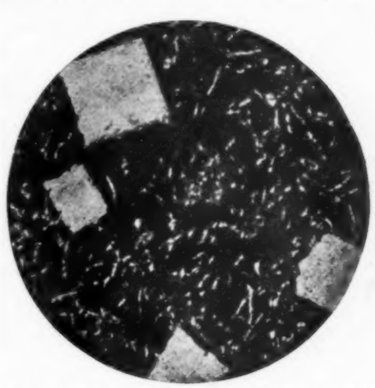

FIG. 2.—Alloy of tin, 90 per cent.; antimony, 10 per cent.

In the same figure some straight edges can be seen, in which the ramifications end, and which sketch out shapes resembling those of crystals of antimony. The presence of these crystallites or incipient crystals in eutectics constitutes one of the resemblances between them and the micro-felsitic basis observed in many igneous rocks, and it seems likely enough that if light transmitted through these alloys could be examined, it would show that they are on the borderland between crystalline and amorphous matter.

[1] "Étude Microscopique des Alliages Métalliques. *Bull. de la Soc. d'Encouragement*, vol. ii. (1897), p. 384.

Besides, the normal type of binary alloys, in which eutectics are observable, there is a second type consisting of alloys of metals which form isomorphous mixtures with each other. These alloys, whatever may be their composition, consist of only one species of crystals, which fill the whole space, the composition and the properties of the alloys usually varying in a continuous manner in each crystal. The number of metals capable of forming

FIG. 3.—Alloy of tin, 75 per cent.; antimony, 25 per cent.

isomorphous mixtures with each other is small, the bismuth-antimony alloys being the only ones out of fourteen series investigated by M. Charpy in which this property was found to exist, but, on the other hand, there are many cases of definite compounds of two metals isomorphous with one of them. Thus, for example, microscopic study has enabled M. Charpy to detect a compound of tin and antimony containing about 50 per

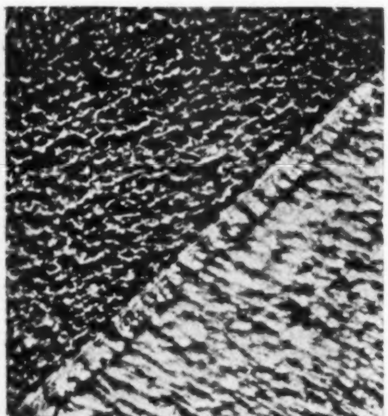

FIG. 4.—Pure gold. × 1000 diameters.

cent. of tin and isomorphous with antimony, although the freezing-point curve, worked out by Roland-Gosselin, and consisting of three branches having their concavities upwards, and meeting in two angular points or maxima, gives no direct indication of the relation between these metals.

In Fig. 2, in which the alloy containing 10 per cent. of antimony is shown, the cubical crystals appear to consist of the 50 per cent. alloy set in a eutectic magma. Fig. 3 shows the alloy with 25 per cent. of antimony. As the proportion of antimony in the whole mass approaches 50 per cent., these crystals invade the whole field, and numerous minute cracks appear, on the edges of which is seen a secondary crystallisation without the interposition of an intermediate substance. This structure is characteristic of a pure or homogeneous substance, as in the beautiful micro-sections of pure gold prepared by Osmond and Roberts-Austen,[1] one of which is reproduced in Fig. 4. When the proportion of antimony is increased above 50 per cent. a eutectic magma shows no signs of reappearing. Similarly in the tin-antimony series, there is evidence of a compound containing 20 per cent. of antimony and isomorphous with silver, and in the silver-tin series a compound containing 30 per cent. of tin also appears to be isomorphous with silver. An investigation of the triple alloys of these metals would be interesting, as probably affording fresh examples of isomorphous series. T. K. R.

NOTES.

THE Municipal Council of Paris has made a grant of three thousand francs to the fund for the erection of a statue of Lavoisier in Paris.

M. MOUREAU has found in the records obtained at the Parc-St.-Maur Magnetic Observatory, a distinct disturbance evidently produced by the Indian earthquake of June 12. The exact time of the magnetic perturbation registered on that day is 11.37 a.m.

AT a recent meeting of the Durham and Northumberland Archæological Society it was unanimously resolved to obtain a portrait of the president, the Rev. W. Greenwell, F.R.S., Canon of Durham, to be placed in the Cathedral Library, Durham. A strong committee has been formed to further this object, and more than one hundred guineas have already been paid or promised. Further subscriptions are invited, and will be received by Mr. C. Rowlandson, at Messrs. Hodgkin's Bank, Durham, or by Mr. J. G. Gradon, Lynton House, Durham.

SIR RUTHERFORD ALCOCK, formerly president of the Royal Geographical Society, died on Tuesday, at the age of eighty-eight. The death is also announced of Prof. C. E. Colby, professor of organic chemistry in Columbia University.

DR. G. H. OTTO VOLGER, who died at Sulzbach, in the Taunus, on October 18, aged seventy-five, was at one time a notable figure in scientific and political circles in Frankfurt. A many-sided man, he contributed during his life a number of miscellaneous papers to various natural history and philosophical societies. He made several original contributions to geology, and wrote on the origin of springs, and on meteorological and mineralogical topics. During the time of his greatest activity, while resident in Frankfurt, he founded a society for the cultivation of sciences and arts called the "Freies deutsches Hochstift." Nearly forty years ago, when the old residence in the Hirschgraben, where Goethe was born, came into the market, he bought it. For a time he lived in it, with the direct object of gradually restoring it, room by room, to the state in which it existed (as described partly in *Dichtung und Wahrheit*, and partly in *Wilhelm Meister*) during the boyhood of the poet. This done, he made over the Goethe-house to the Hochstift, of which he was then, and for twenty-two years, the president.

[1] Osmond and Roberts-Austen, "On the Structure of Metals, its Origin and Changes," *Phil. Trans.*, vol. clxxxvii. (1896), A., pp. 417-432.

After Frankfurt had ceased to be a free city, and imperial ideas swept over the old place, Dr. Volger found himself increasingly out of harmony with the new *régime*, and he withdrew from Frankfurt, first to Soden and lately to Sulzbach. In accordance with his express wish, his funeral at Frankfurt, on the 20th ult., was strictly private.

WE have received the Year-book of the Cambridge Philosophical Society, containing the addresses of the Fellows of the Society, and a list of the English and Foreign Societies with whom the publications of the Society are exchanged. It would appear that the Society is a convenient meeting-ground for Cambridge men engaged in scientific work. Papers for presentation to the Society are received by the Secretaries at the library of the Cambridge Philosophical Society, Cambridge. The Proceedings are published three times yearly—the publication of the Transactions is to be accelerated: the meetings are held every fortnight during full term. The following is a list of the new honorary members, elected May 24, 1897:—Major Macmahon, R.A., Prof. Charles A. Young (Princeton), Prof. Michelson (Chicago), Dr. Boltzmann (Vienna), Prof. Righi (Bologna), Prof. Mendeléeff (St. Petersburg), Sir Archibald Geikie, Prof. Dana (New Haven, Conn), Sir John Kirk, Prince of Monaco, Rev. Canon Norman (Durham), Prof. Wilhelm Pfeffer (Leipzig).

AN instructive fisheries exhibition, arranged to illustrate the fishing industries and the application of science to agriculture, was opened in the Zoological Museum of the University College, Liverpool, on Friday last. The exhibits are fully described in a guide to the exhibition published by the authorities. There is a series of the food fishes of this district, with the more important food matters of each; also a series of useful and useless fishes which compete with one another by eating the same food. Another exhibit contains specimens of the shell-fish of the district, showing stages in the life-history and growth, legal and illegal sizes, pearl formations, and pearls. A case is devoted to a display of printed matter, plates, photographs, drawings, and lantern slides, illustrating the publications, both administrative and scientific, of the Lancashire Sea Fisheries Committee, and other work bearing upon the fisheries of the district. The drawings and sketches include a number made by Prof. Herdman in illustration of his joint investigation with Prof. Boyce on the diseases of oysters and the connection between the oyster and disease. The exhibition will no doubt promote a more widespread interest upon the important question of sea-fishing, and thus assist in increasing the harvest of the sea. As Prof. Herdman pointed out at the opening ceremony of the exhibition, fishes are animals, their food is composed of animals, and their enemies are animals. In all the operations of their life, their feeding and breeding, and so on, they are subject to the same biological laws which regulate the lives of all animals in the sea. The investigation of fishery questions is applied biology, and if our fisheries are to be benefited they must be treated in a scientific manner. We do not trust to unaided nature for our supplies of bread-stuffs and beef. Why then should we trust to nature for fish? As there is an agriculture of the land, so there must be an aquiculture of the sea. Fishermen must in the future be farmers of the sea-shore, not hunters as they have been in the past.

SIR J. WOLFE BARRY, in an address at the opening of the new session of the Institution of Civil Engineers on Tuesday, said that the Institution now numbers on its roll 7075 persons. Reviewing the subject of the examinations recently instituted, he pointed out that they are intended to show that candidates for election into the class of Associate Members are acquainted with those general principles which have always been and must be recognised as the basis of the engineering profession, and also to make clear that each candidate possesses a somewhat fuller scientific knowledge of the elements of the particular branch in which his special training has lain. Practical knowledge is no less necessary now than formerly; for the examinations have not been instituted in lieu of other qualifications set out in the by-laws, but in addition to and supplementary of them.

WE have received the Report on the Administration of the Meteorological Department of the Government of India in 1896 97. It is divided into two parts; the first gives a general account of the results during the past year, and the second gives details of administration, chiefly in the form of tables. In the branch of marine meteorology two clerks have been regularly engaged in collecting data from ships visiting Calcutta and Bombay, and more than two thousand logs have been extracted. The observations are tabulated day by day, and are utilised in the preparation of charts of the Monsoon area. Observations have been made for some years past in certain forest areas with reference to the influence of forest-growth upon the distribution of rainfall, but have now been discontinued. Photogrammetric cloud observations have been regularly made since March last at Calcutta and Allahabad with the best type of instruments, which were constructed in Paris. Storm warnings are issued when necessary, partly from Calcutta and partly from Simla, and timely notice appears to have been given of all the more important disturbances. Among the various useful publications, we may mention the printing of the hourly observations formerly made at Trevandrum, under the superintendence of the late J. Allan Broun. The work of publication of the hourly values is now completed, and Mr. Eliot has undertaken their discussion, from which we anticipate some valuable results. He hopes to complete it during the present year.

A RECENT number of the Cape of Good Hope *Agricultural Journal* contains an important report on rinderpest by three Russian investigators, M. Nencki, N. Sieber, and W. Wyznikiewicz. These gentlemen were appointed by the Russian Government two years ago, to study how far sheep of the Merino family are subject to rinderpest, and at the same time to investigate the nature of the contagium of this disease. Their inquiries were carried on first in the Kuban-Cossack country, and later at the Institute for experimental medicine in St. Petersburg. They claim to have discovered the genuine contagium of rinderpest, which does not belong to the bacterial class of germs, but appears to partake more of the character of the amœba. After experimenting with about a hundred different media, in the hope of separating out the specific rinderpest agent, their efforts were rewarded by the discovery of "slightly luminous bodies in size from 1–3 μ, mostly round, a few being oval, pear-shaped, or drawn to a point. On the larger ones swellings may be seen, and, in a few, a grain lying in the centre. The larger and duller individuals show amœboid developments; some also have one, seldom two, ciliated protrusions." With fresh cultures of these organisms the rinderpest can be generated. Such cultures, however, are very perishable, and it is recommended to re-inoculate the culture daily. The best material for the cultivation of these organisms is apparently that which is rich in animal mucus, and by employing solutions containing an abundance of mucine, the authors succeeded in at length obtaining them in a living condition outside the animal's body. Great difficulty was experienced in ensuring the virulence of rinderpest cultures, but this trouble has to a considerable extent been overcome. "All organs and juices of diseased animals contain the rinderpest germ," the authors assert; and now that their methods have been brought before the scientific world, it only remains for other investigators to repeat and, we trust, confirm the important results which have been obtained.

THE first number (November) of the new volume of the *Century Magazine* contains several contributions of scientific interest. Prof. H. F. Osborn writes an appreciative notice (accompanied by a portrait) of the late Prof. Cope. Shortly before his death Prof. Cope communicated to Mr. W. H. Ballou a number of interesting views which he held as the result of many years' study of the skeletons of Saurians, or lizard-like reptiles, found in various beds of the Rocky Mountains and other regions of the United States. He had arrived at some original and ingenious speculations with regard to the structures and habits of these animals, and, in addition, he completed the evolution of the carnivorous line of Saurians. Mr. Ballou now presents these views in an interesting article containing several vigorous illustrations, in which Mr. Knight well conveys Prof. Cope's impressions of how ancient Saurians lived and moved.—Mr. Jonas Stadling, who witnessed the start of Herr Andrée's balloon expedition towards the north pole, contributes to the *Century* a short description of the preliminary arrangements, accompanied by several reproductions of photographs of the balloon when beginning its journey. Mr. Stadling states that the balloon lost about fifty cubic metres of gas every twenty-four hours when it was standing filled in the balloon-house, from which rate of escape of gas it is concluded that the balloon would float about thirty days.—Accompanying an article upon Mrs. Cameron and her photographs, in the *Century*, is a fine reproduction of her successful portrait of Sir John Herschel.

THE continually increasing difficulty of dealing with the sewage of large towns lends an interest to any scheme which appears to give satisfactory results in the purification of the effluent from the sewers so as to render it fit to flow into the rivers without polluting the water, and creating a nuisance. So great is the difficulty and cost of purifying the sewage up to the required standard, that Manchester has been advised that the only practicable way of disposing of the effluent from the sewage tanks, which now flows into and pollutes the Ship Canal, is by constructing a culvert fifteen miles long for the purpose of conveying it to the estuary of the Mersey at a cost of 258,000*l.*, and it is intended to apply to Parliament in the ensuing session for the necessary power to carry this work out. The sludge from the tanks is to be taken out to sea. The County Council of London employ a fleet of six steamers which are regularly engaged in conveying the sludge deposited in the outfall tanks at Barking and Crossness a distance of fifty miles to Barrow Deeps at an annual cost of 32,000*l.*; the material so removed amounting to over two million tons a year. At Exeter a new system of "septic" treatment has been tried, and it is described by Mr. Cameron, the City Surveyor, in a paper read before the Devon and Exeter Architectural Society. It is claimed for this system that the sewage treated by this process in the tanks is brought under the influence of micro-organisms; the decomposition of the matters which would otherwise undergo putrefaction being effected by the presence of these micro-organisms, their products being ammonia and carbonic acid with some other gases. The bottom of the tanks after six months' use, when exposed, showed only a thin layer of black earthy matter, together with mud and grit. The effluent is not offensive, and it is stated that it does not ferment. At Wolverhampton recent experiments have shown that filtering the sewage through coal-dust is an effectual way of purifying it, and that a very satisfactory effluent can be obtained by passing 200 gallons of sewage through one square yard of filtering material in twenty-four hours.

THE interest of the many recent observations of earthquake-pulsations has led Dr. M. Baratta, who is preparing a history of seismology, to search for early accounts of these phenomena in various scientific works. He has succeeded in discovering several forgotten records, which are described in a paper in the *Rivista Geografica Italiana* (1897, fasc. viii.). Those of pulsations observed with magnetic apparatus date back to 1681, with astronomical instruments to 1767, and with levels to 1833. Dr. Baratta's examples are taken from French and Italian sources; and it can hardly be doubted that others, equally interesting, would be obtained from an examination of English and German works.

IN an interesting and well-illustrated little memoir on "L'Echelle réduite des expériences géologiques," in the *Revue de l'Université de Bruxelles*, M. W. Prinz sets himself to answer the question whether experiments conducted to explain geological phenomena become untrustworthy on account of the small scale and different materials with which they are necessarily performed. His answer is decisively negative. The results of experiments like those of Cadell on the production of planes of major and minor thrust are exactly similar to those produced in the planing of steel, the difference in scale between the two classes of experiments being greater than that between Cadell's thrusts and those of the Highlands which they were intended to explain. With regard to difference of material results similar to those of Daubrée on plate-glass may be reproduced in mastic, cast-iron, modelling clay, and half-solid mortar; in all cases cracks similar to the joints and cleavage in rocks are produced. Again, the differential movement which makes marginal crevasses in glaciers may be imitated in the cutting of glass by a wheel, by drawing a needle over dry plaster, by a pencil on paper, by footsteps, or by dragging a cane over thick snow, and even by moving a cart-wheel over a muddy road. Further instances, including the action of a diamond on glass, and a bibliography, conclude this interesting memoir.

MR. ALBERT F. WOODS, of the Division of Vegetable Physiology and Pathology, United States Department of Agriculture, describes in the *Botanical Gazette* a novel method of preserving the green colour of plants for exhibition purposes. The principle involved is to bring about a combination of the chlorophyll in the cells of the plant with copper. The resulting compound, copper phyllocyanate, is practically insoluble in any of the ordinary preserving media except strong alcohol, and is not destroyed by light. The resulting green can scarcely be distinguished from the normal chlorophyll green. The process described is a somewhat complicated one. After removing the air as completely as possible from the surface and from the intercellular spaces by immersion in 90-95 per cent. alcohol, or by means of the air-pump, the tissues are placed in a 5 per cent. solution of glycerol containing enough dissolved copper sulphate or copper acetate to give it a bluish tint. The uncombined copper is dissolved out by a dilute glycerin-formalin solution, and the object may be preserved in this solution or in any of the usual media except strong alcohol.

THE number of printed specifications of patents in the Patent Office Library at the present time is well over a quarter of a million. To search through these specifications in order to obtain information as to the novelty of an invention is thus a tremendous task even for the trained expert; yet by omitting such a search many a patentee has found, after paying his fees, that his patent was worthless, because it had been anticipated; for the Patent Laws of this country make no provision for an official search as regards novelty, and all patents are taken out at the risk of the inventors. The searcher is, however, greatly assisted in his task by a series of indexes and abridgments published by the Patent Office as a guide to the specifications themselves, and freely distributed to the principal public libraries in this country. The abridgments give a general description of the nature of every invention patented, and the object of their publication is to enable the would-be patentee to carry out, at any rate in some

cases, what may be termed a fireside search. The volume containing abridgments of patents belonging to the class of *Philosophical Instruments*, and referring to the years 1884–88, has been sent to us by the Comptroller-General of Patents. In it we find concise descriptions (usually illustrated by diagrams) of optical, nautical, surveying, mathematical, and meteorological instruments and accessories. Some of the subjects of the patents are very trivial, while others are most ingenious; so an examination of the whole will be found amusing as well as instructive. The favourite scientific instruments upon which human ingenuity exercises its powers seem to be barometers, clinometers and other instruments for measuring vertical angles, magnetic compasses, hygrometers and hygroscopes, lenses, levels and plumbing instruments, logs and leeway indicators, magic-lanterns and other projecting apparatus, mathematical drawing instruments, microscopes, reflectors, protractors, sounding apparatus, spectacles and eye-glasses, surveying instruments, telemeters, thermometers and pyrometers, and stands for cameras and telescopes. The volume thus provides the material for a liberal education in the construction of scientific apparatus, in addition to which it is full of interest to every one with an inventive turn of mind.

IN the current number of the "Annotationes Zoologicæ Japonenses" Mr. Nishikawa describes a newly-discovered mode by which the eye of the lower side of a flatfish travels round to the upper side during metamorphosis. Agassiz observed that in the majority of flatfishes the eye of the (eventually) blind side travels round the dorsal edge of the head until it attains its final position, and that not until this rotation is completed does the dorsal fin grow forwards beyond the level of the eyes. In *Plagusia*, on the other hand, the dorsal fin is known to grow forwards to the snout while the eyes are still symmetrical, and the right eye attains its final position on the left side of the fin by penetrating, in the course of its rotation, through the soft tissues at the base of the fin. In the fish observed by Mr. Nishikawa the dorsal fin also grows forward before the rotation of the right eye, but this anterior extension does not unite with the head until after the rotation is completed. Its ventral margin is contiguous with the dorsal surface of the head except posteriorly where there is a distinct hole, bounded by the head and the anterior extension of the fin, for the passage of the right eye, which thus travels round the dorsal side of the head without sinking into its tissues. It is clear, as Mr. Nishikawa points out, that the mode by which the change of position is effected in this fish is intermediate between that observed in ordinary flatfishes, which are destitute of an anterior extension of the dorsal fin at the time of transformation, and that which is exhibited by *Arnoglossus* and *Plagusia*, in which types the anterior extension of the fin coalesces with the head before rotation of the eye, and requires to be perforated for the passage of that organ. The genus of the Japanese fish could not be ascertained with certainty, but it is believed to be closely related to the genus *Plagusia*.

THE forty-third annual report dealing with the work of the Australian Museum, Sydney, during the year 1896, has just come to hand. The most important presentations to the Museum during the year was the Dobroyde collection of Australian birds and eggs, containing several thousand skins and eggs—the result of forty years collecting. This was purchased by the Government of New South Wales from Mr. J. S. Ramsay, and transferred to the custody of the Trustees of the Museum. Another valuable donation is a mass of meteoric iron weighing just over 44 lb., found on the Nocoleche Holding, near Wanaaring, New South Wales, and presented to the Museum by Mr. G. J. Raffel. The semi-fossil remains of a Dugong, discovered in the excavations for a canal, near Sydney, have also been presented to the Museum. This is the first instance of the discovery of Dugong remains so far south. Among other noteworthy acquisitions are: The bower or playground of Newton's Bower-bird (*Prionodura newtoniana*), types of the Honey-ants of the Horn Central Australian Exploring Expedition, and a further collection of bird skins from the same, some ancient Peruvian urns, a collection of Australian Coleoptera, and the remains of the Asiatic elephant Jumbo. Mr. Charles Hedley, one of the officers of the Museum, who was permitted to accompany the Royal Society's Coral Reef Boring Expedition, succeeded in amassing an interesting collection during his stay on Funafuti, particularly of invertebrate and ethnological subjects. The collections are now in process of description by the scientific staff of the Museum. A commencement has been made at the works for extension of the Museum buildings, for which a sum of 6000*l*. was voted by the New South Wales Parliament in 1895. The old ant-eaten roof has been removed, and a new roof, built of steel, wood and copper, has been constructed. While this was in progress a thorough inspection of the building was made to ascertain the extent of the ravages of the "white ant," with the result that further depredations were discovered. These terrible termites were found to have penetrated under the floor of the ethnological hall, and completely destroyed the woodwork of that structure as of the roof. It is not surprising to read that discoveries of this kind gave the curator, Mr. R. Etheridge, jun., plenty of cause for anxiety during last year. The chief change in the staff of the Museum is the appointment of Mr. W. J. Rainbow to succeed the late Mr. F. A. A. Skuse as officer in charge of the entomological collections.

THE difficulty of the problems which await the investigator into the chemistry of the enzymes is well illustrated by the results, published in the current *Berichte*, of an attempt made by A. Wroblewski to isolate diastase. The greater part of the substance usually known as diastase was found to be a carbohydrate, which yielded arabinose when boiled with acids. The active constituent, on the other hand, was found to have all the properties of a protein, although the author could not be sure that he had prepared it in an absolutely pure state. The proteid nature of the enzyme follows from the facts that the residue left after removing the inactive carbohydrate shows all the characteristics of a proteid body, and at the same time exerts the diastatic action on starch. This research affords, for the first time, a definite experimental basis for the enrolment of this enzyme among the proteids, although many investigators had taken this view of its nature on general grounds.

THE *Bulletin* of the Bussey Institution, vol. ii. part 6, published under the authority of Harvard University, consists of a paper by Prof. F. H. Storer, on some of the chemical substances in the trunks of trees, which serves to show that other substances besides starch are stored up in large quantities as reserve food-material in the winter, to be converted into sugars in the spring.

THE additions to the Zoological Society's Gardens during the past week include a White-crested Tiger Bittern (*Tigriosoma leucolophum*) from West Africa, presented by Dr. J. F. Dell; an Alligator (*Alligator mississippiensis*) from Southern North America, presented by Mr. J. H. Renals; a Common Chamæleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. G. E. Gratton; two Great-billed Rhea (*Rhea macrorhyncha*) from North-east Brazil; a Pennant's Parrakeet (*Platycercus pennanti*) from Australia, deposited; six Common Rhea (*Rhea americana*), bred in Holland; a Many-coloured Parrakeet (*Psephotus multicolor*) from Australia, purchased; a Sambur Deer (*Cervus aristotelis*, ♀), a Hog Deer (*Cervus porcinus*, ♀) from India, received in exchange; three Shaw's Gerbilles (*Gerbillus shawi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE PHOTOGRAPHY OF FAINT MOVING CELESTIAL OBJECTS.—An ingenious but simple method of photographing unseen or very faint moving but known celestial objects has recently been suggested by Prof. Barnard (*Astr. Nachr.* No. 3453). Every one knows that in order to photograph a faint celestial object, it is only necessary to prolong the exposure until a sufficiently burnt-out image is recorded on the photographic plate. If, however, the object has a rapid motion, then the image will not remain on one part of the plate a sufficiently long time to record its impression, since the clockwork of the instrument is regulated to counterbalance the apparent motion of the stars. Prof. Barnard's idea is to use, in the eyepiece of the guiding telescope for following the object in question, two guiding cross wires attached to a light frame which can be moved by a delicate clockwork (the works of an ordinary watch are sufficient), the speed of which can be regulated to the motion of the object. Arrangements can also be made that its direction of motion can be regulated to any position-angle. When adjusted to the eye end of the guiding telescope, the instrument is set so that the amount and direction of motion of the cross wires shall coincide with that of the comet or minor planet.

A star in the field of view is then bisected by the cross wires, and the mechanism set in operation, the star being kept bisected by the ordinary slow motions for star guiding. It will thus be seen that although the operation is exactly the same as if the star itself were being photographed, it is the image of the comet which will remain stationary as regards the photographic plate, while the stars will produce trails. Prof. Barnard mentions that the device will be very serviceable for photographing visible comets with ill-defined nuclei, as these have no definite points to guide by, and it is for this work that he is going to have an instrument of this kind made.

SUNSPOTS AND THE WEATHER.—Although nearly every one is agreed that sunspots do influence our weather, the relation between them is evidently not a very simple one. Statistics of the weather from places situated in moderate latitudes do not, at any rate, bring out very clearly direct indications of such a connection; but when they are gathered from a large region near the equator, such as India, then the effect of the sunspot cycle on the weather is more decisive. The first effects of solar disturbances would be felt at the equator, and as the mean temperature does not vary very much from the extremes, a general small increase or decrease would make itself apparent. In more northern latitudes local disturbances seem to tend to a great extent to mask the effects of a variation in the amount of solar radiation.

Mr. Alexander MacDowall has, however, examined a number of weather statistics from several European stations—viz. Bremen, Paris, Geneva, Greenwich—and he finds that they are suggestive of a relation to the sunspot cycle (*Quarterly Journal of the Royal Meteorological Society*, vol. xxiii. No. 103).

In making out his curves he says he has used smoothing methods freely, sometimes smoothing with averages of five and sometimes with additions of five. In this investigation the author has compared corresponding portions of successive years, such as the winter half, summer half, the four seasons, &c. To sum up the inquiry in his own words, he says: "In the climate of Western Europe there is apparently a tendency to greater heat in the summer half and to greater cold in the winter half near the phases of minimum sunspots than near the phases of maximum; the contrast between the cold and heat of the year thus tending to be intensified about the time of minimum sunspots. . . . If we accept the view to which direct observation of the sun seems to lead, that solar radiation of heat is greater about the time of maximum sunspots, we appear to have a direct explanation why, on the one hand, our winter cold should thus be moderated; and as to the contrary effect in the summer half, it is not difficult to conceive that solar activity may, by increased evaporation, bring about the presence of more cloud, and so give us cool, rather than hot, summers."

The conclusions drawn by Mr. MacDowall are exactly what would be expected, and they corroborate those that were formed many years ago. Thus, for instance, in a pamphlet published in 1879, and submitted to the Indian Famine Commission, we read: "For it is an acknowledged and readily accountable fact that presence of cloud in the summer is associated with coolness, and in the winter with warmth; and in like manner that a clear sky, which in the summer, by promoting solar radiation, favours the development of great heat, in the winter, by giving free scope to terrestrial radiation (in the then comparative absence of solar radiation), tends to produce excessive cold. The fact, therefore, that clouds are more prevalent in the *summers* of maximum sunspot years, and in the *winters* of minimum sunspot years, is only another way of saying that both summer and winter are *cooler* at the former epoch and *warmer* at the latter."

COMET PERRINE, OCTOBER 16.—The following is a continuation of the ephemeris of this comet, computed by Herr. J. Möller (*Astr. Nachr.*, No. 3454) from the observations of October 16, Mount Hamilton; October 18, Strassburg, and October 20, Hamburg (two observations).

12h. Berlin M.T.

1897.	R.A. h. m. s.	Decl. ° ′	log *r*.	log Δ.	Br.
Nov. 7	19 25 54	+75 21·9	0·1563	9·9387	1·0
8	15 59	74 19·4	1550	9429	1·0
9	7 31	73 17·0	1537	9473	1·0
10	19 0 19	72 15·0	1524	9517	1·0
11	18 54 10	71 14·0	1512	9563	1·0
12	48 51	70 14·1	1500	9609	1·0
13	44 13	69 15·4	1488	9656	1·0
14	40 10	68 18·0	1477	9703	0·9
15	36 36	67 22·0	1466	9751	0·9
16	18 33 30	+66 27·5	0·1456	9·9799	0·9

The following comments relate to the appearance of this comet:—

Karl Mysz: 6-inch refractor in Pola. October 18, comet 10 mag.; axis of tail, 200°; nucleus appears sometimes double or oblong. October 19, same appearance and brightness as yesterday; nebulosity has diameter of 5′.

J. Möller: 8-inch refractor in Kiel. October 20, nucleus 10·3 mag., oblong and hazy; fan-shaped tail of about 2′ in length, having a position angle of 200°.

Schorr and Ludendorff: Hamburg refractor. October 20, comet has faint nucleus, 10·5 mag.; tail, 0′·5 towards south. October 24, fainter than October 20; no distinct nucleus.

Picart: at Bordeaux, October 20. The comet has a very feeble tail; its general form is that of an elliptical nebula.

THE DIRECTOR OF THE LICK OBSERVATORY.—We regret to read in the *Astronomische Nachrichten* (No. 3454) that, after a continuous connection with the Lick Observatory for twenty-three years, and a service at Mount Hamilton since the year 1888, Prof. Holden has resigned his post, and will terminate his official relations with the Observatory December 31, 1897. His address after October 1 will be Smithsonian Institution, Washington.

RELATION BETWEEN INDIVIDUAL AND RACIAL VARIABILITY.[1]

MR. BREWSTER'S memoir refers to "allied races" without defining that phrase, but apparently basing it on the idea of divergent races sprung from a common source. The mean (or typical) characters of these races differing from one another, as individuals of the same race differ among themselves, two systems of variables exist in respect to each and every character: (1) a single system, referring to the means of the different races; (2) several separate systems, referring alike to the individual values of the same character; in each and every race. He supposes the ordinary law of frequency to be approximately applicable to both systems, so that the peculiarities of every series admit of being roughly expressed by its own mean and quartile (=probable error). In order to reduce the variability of each series to a common scale, he works, not with the observed quartiles, but with what may be called *reduced quartiles*, namely the indices formed by dividing each quartile by its corresponding mean. These being comparable on equal terms, are his "measures of variability."

The first and more important part of the memoir deals with eighteen different characters in eight human races, the data being derived from Weisbach's *Körpermessungen*. The number of individuals in each of the selected races is unfortunately very small, ranging from eight to twenty-six, though he is able to

[1] "A Measure of Variability and the relation of Individual Variations to Specific Differences." By Edwin Tenney Brewster. (*Proc.* Amer. Acad. Arts and Sciences, May 1897.)

utilise twenty races for obtaining the common racial mean. His method of discussion is based on the safe ground that, if racial variability be associated with individual variability, whenever any specified character is more variable than another specified character in the one, it will (on the whole) be more variable in the other also. Therefore if the reduced quartiles of the two characters, in the series of means of races, be called A and B, and those in that of the individuals of any given race be called *a* and *b*, then if A be greater than *a*, B would (on the whole) be greater than *b*, and conversely. More briefly and fully, if the *signs* of the differences (A-B) and (*a–b*) are alike, the evidence, so far as it goes, favours the suggested idea of a connection between racial and individual variability; if the signs are different it discountenances it.

The test is rough, but is of value when applied on a considerable scale with concurrent results, as in the present instance. The eighteen characters admit of $\frac{1}{2}$ $(18 \times 17) = 153$ different pairs of combinations of the form (*a–b*), in each of the eight races; that is 1224 pairs in all. Each of these has been compared with its associated pair in the series of means of races, of which there are altogether $\frac{1}{2}$ $(8 \times 7) = 28$. The result is that in seven out of the eight races the cases testifying to the existence of the suggested association are from twice to thrice as numerous as the others, and in the eighth race they are $1\frac{1}{2}$ times as numerous. Nay more, there is some evidence that the most variable characters in the one, are the most variable in the other. This conclusion is corroborated by three other inquiries of the same kind, two into rodents and one into carnivoræ. The error introduced by the strained assumption, that the ordinary law of frequency holds good for the series of means of allied races, does not seem likely to invalidate the general conclusion to a serious extent. It therefore appears that Mr. Brewster has provisionally established his thesis that whenever any specified character varies much in individuals of the same race, it is probable that it will be found to vary much in "allied" races, and conversely.

ON THE CONSTITUTION OF THE ELECTRIC SPARK.[1]

IF a Leyden jar is discharged through metal electrodes, and the spectrum of the spark is examined, it is found that the metallic lines are not confined to the immediate neighbourhood of the poles, but are seen sometimes in the centre of the spark, several millimetres away from the electrodes, from which they must have been projected with considerable velocity.

It has always seemed to me to be a problem of interest, to measure the velocity of projection. A knowledge of it may teach us something concerning the mechanism of electric sparks and, in addition, we may hope to obtain information on some important points in spectrum analysis, which are at present under discussion. Thus, for instance, if the speed with which a molecule is pushed forward into the centre of the spark depends on molecular weight, we may separate from each other those lines of the spectrum which belong to different molecular combinations. For many years past I had made various unsuccessful attempts to deal with this problem, when I became acquainted with the elegant method, used by Prof. Dixon in some of his recent experiments, in which a photograph is taken on a film fixed to the rim of a rapidly revolving wheel, of which the speed may easily be made sufficiently large to measure velocities of moving luminous particles up to 2000 $\frac{\text{metres}}{\text{second}}$. This number might be doubled or trebled with improved appliances.

The experiments were conducted by Mr. Gustav Hemsalech, to whose care and skill their success is largely due. Without entering into a detailed description of the apparatus, it will be sufficient to say that the photographs, which I now submit to the Section, were taken on a film moving with a linear speed of about 80 $\frac{\text{metres}}{\text{second}}$ in a direction at right angles to the slit of the spectroscope. The lines of the metal appear inclined instead of straight, in consequence of the finite velocity of the luminous molecules. The air lines, on the other hand, though slightly broadened, remain straight. The sparks were taken from five large Leyden jars, charged by means of a Voss machine. Each single spark produces a good spectrum, reaching approximately from $\lambda = 5000$ to $\lambda = 4000$.

One of the photographs, in which zinc poles were used, shows that the velocity of the molecules is gradually diminishing as they move away from the pole. Close to it the speed seems very great, the average velocity up to a distance of about one millimetre being about 2000 metres per second. At a distance of four millimetres the speed is reduced to something like 400.

In another experiment one pole was zinc, while the other was bismuth. Some bismuth lines are found to be decidedly more curved than those of zinc, indicating a smaller velocity. But the line of bismuth, which lies at 4560, seems almost straight.

When the poles are moistened with a solution of calcium chloride interesting results are obtained, the calcium line at 4226 being more inclined than H and K.

The experiments were made with comparatively rough appliances, but a more perfect apparatus is in course of construction; and the author hopes to continue the research in conjunction with Mr. Hemsalech.

[1] By Prof. Arthur Schuster, F.R.S. (Read before Section A of the British Association at the Toronto meeting.)

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE section of Physiology at the British Association meeting at Toronto was a large and active one. Under the presidency of Prof. Michael Foster a large body of physiologists attended in about equal numbers from the east and west of the Atlantic. Meetings were held on the Thursday and Friday, August 19 and 20, and on the Monday, Tuesday and Wednesday, August 23, 24 and 25.

Among those present were Messrs. Bowditch, Boyce, Cushny, Crookshank, Gaskell, Halliburton, Huber, Huerthle, Lee, Loeb, Lombard, Billings, Lister, Macallum, Osler, Wesley Mills, Noël Paton, Porter, Waymouth Reid, Sherrington, G. N. Stewart, Anderson Stuart, Kellog, W. H. Thompson, Charles Richet, Waller, Welby, Shore, MacAlister, O. Grunbaum, Baldwin, Braun, Reynolds Green, Meldola, and A. S. Grunbaum.

Prominent among proceedings in the Section were the following:—

Prof. Bowditch read a paper on the physiology of unstriped muscular tissue as exemplified in the wall of the stomach of the frog. The rhythmic contractility of the tissue is well seen. When the organ or a strip of it is fitted to a recording apparatus, in the majority of instances after a lapse of not more than three hours, contractions of rhythmic recurrence are registered. Often two or more sets of rhythmic contractions are superposed. This may be best accounted for by supposing the muscle-cells to contract not all together but in two or more groups. In the discussion Prof. Sherrington referred to experiments published by him in which had been recorded contractions of the urinary bladder removed from freshly-killed monkeys and placed in warm normal saline solution, while connected with a volume recorder. In these the isolated bladder began to "beat" almost at once, and continued "beating" for an hour or less, at rate somewhat quicker than once a minute. The contractions thus obtained from the viscus only exceptionally displayed the compound character shown in Prof. Bowditch's curves.

Prof. Carl Huber brought forward observations on the cells of the sympathetic system of vertebrates. In Amphibia nearly all sympathetic cells are unipolar. In other vertebrates the prevailing type is multipolar. All sympathetic neurons have one axon only. The dendrites form a network between the cell-bodies of the neurons constituting a ganglion. The axon of each sympathetic nerve-cell becomes either a non-myelinated nerve-fibre (grey fibre) or a fine myelinated nerve-fibre. The fibres of the white rami are axons of cells lying within the spinal cord, and these axons reach the sympathetic ganglia through the white rami, and in the ganglia undergo branching, ending in baskets which enclose the perikarya of the sympathetic neurons. In mammalia and birds the circumcellular baskets are comparatively simple networks of varicose fibrillæ. In Reptilia and Amphibia instead of simple end baskets the fibre is spirally wound and completely contorted. This is the explanation of Beale's spiral fibre in the sympathetic cells of the frog figured by him forty years ago. In all vertebrates the pericellular baskets are intracapsular. Langley and his pupils have shown that an impulse travelling along a spino-sympathetic efferent chain may be blocked in a sympathetic ganglion by the injection of nicotin. This has been applied to practically all regions of the

sympathetic by studies carried out on Langley and Sherrington's pilomotor nerve-system. Huber suggests that the nicotin paralyses not the perikarya of the sympathetic neurons, but rather the end baskets of the pre-ganglionic fibres.

Prof. G. N. Stewart brought forward the results of the application of a new modification of his electrical method of determining speed of blood flow to the question of the output of the mammalian heart. The method depends upon the change of resistance to the passage of electric currents through the blood in an artery or vein brought about by injection of blood serum. Serum conducts better than does entire blood. When the blood admixed with serum reaches the point of blood vessel under examination, electric currents previously balanced by a Wheatstone bridge are thrown out of balance, and it is arranged that a telephone shall announce this event. A specimen of blood is drawn from the corresponding artery in the other limb, and from this is determined the amount of serum which must be added to the normal blood to make its resistance equal to that collected during the passage of the mixture. The output of the heart can, from these data, be determined for the period of injection, and consequently by knowing the pulse-frequency be determined for a single beat. In the dog it is about 2·3 c.c. per second per kilogramme of body-weight.

Prof. Townsend Porter gave an account of observations made upon a strip of the muscle of the apex of the dog's ventricle. The strip is left attached only by a band of pericardium, and yet exhibits in this isolated state rhythmic spontaneous beats. The rhythm of its beat is slow but perfectly regular; it is slower than the rhythm of the rest of the ventricle; it, of course, persisted when the rest of the ventricle was arrested by excitation of the vagus nerve. The blood supply was maintained in the strip by means of an artery and vein in the pericardium. The isolation of the strip from the rest of the myocardium is found, even under microscopical examination, to be absolutely complete. The contractions of the isolated piece could not have been caused by excitation by the action-current accompanying the systole of the rest of the ventricle, as the piece was raised freely in the air. The asynchronism of the beat of the isolated strip and rest of the ventricle prove the same thing, also that the strip was not discharged by nerves accompanying the blood vessels to the strip. Other experiments showed that if an artificial circulation of diluted blood be kept up through the extreme apex of the dog's heart excised and hung up on cannulæ the isolated apex will be vigorously, coordinately, and regularly for several hours. Hence it is concluded that the apex and other parts of the mammalian heart possess spontaneous rhythmic contractility, that the cause of rhythmic contraction is not a single localised coordination centre, the mechanism of coordination, whatever it be, being present in all parts of the ventricle.

Prof. Porter also described experiments confirming MacWilliam's statement that the ventricle of the dog's heart can be recovered from fibrillary contractions. The entire heart of the cat can be readily made to recover even after long-continued and violent fibrillary contraction by free and steady perfusion of fresh blood through the coronary vessels.

When a vein on the surface of the ventricle *in situ* in the living animal is incised and the heart slowed by vagus excitation, the flow from the cut vein is much increased during ventricular contraction. The contraction of the cardiac muscle compresses the veins, and to a less extent the arteries, in the substance of the heart. The systole aids the circulation of blood through the heart muscle. On the other hand, observations with minimum manometers on the veins of the heart give no support to the view that the heart acts on the coronary circulation to any extent as a suction-pump, although efficiently as a force-pump. A circulation through the vessels of Thebesius was demonstrated to be sufficient to keep up the rhythmic beat of the right venticle after the coronary arteries have been closed. Ringer's solution will not maintain the activity of the mammalian heart, but diluted fresh defibrinated blood will.

Prof. Waymouth Reid gave an account of his most recent researches on absorption in the intestine. Heidenhain demonstrated the fact that the water, organic and inorganic solids, of serum introduced into the intestine, are absorbed. The experiment was devised in support of the theory that intestinal absorption is possible under conditions in which osmotic transfer is excluded, and it was found that even inspissated serum is absorbed. Heidenhain omitted to measure the hydrostatic pressure on either side of the intestinal membrane, so that the possibility of the result being due to filtration was not excluded; and, indeed, the ancient filtration theory of Lieberkühn has, with the necessary modern histological modifications, been revived of late by Hamburger. In the experiments now described, the animal's own serum (obtained by the centrifugal machine) was introduced into a loop of its intestine, and the hydrostatic pressure in the cavity of the experimental loop, and in a mesenteric vein proceeding from a control loop, filled with "normal saline" solution, observed continuously during the course of the experiment. Prof. Reid now found that water, organic and inorganic solids, are absorbed against considerable excess of hydrostatic pressure in the blood-vessels. (Since the velocity of the blood-stream in capillaries is low, it is taken for granted that the pressure in the capillaries of the intestinal villi is not lower than that in a mesenteric vein at the border of the gut.) The results of his experiments are practically the same when all the lacteals leaving the experimental loop of intestine have been occluded by ligature.

Prof. Reid called attention to our present inability to explain the phenomena. Great difficulties are offered in the face of the following points, examined and proven by his experiments.

(1) Osmosis, filtration into the blood capillaries, or into the lacteals by the action of Brücke's "villus pump" are, it is considered, excluded by the conditions of the experiment.

(2) That the disappearance of the serum from the cavity of the gut is simply a matter of imbibition is in the highest degree improbable, because the cells must be, at the commencement of the experiment, soaked to the highest degree possible in those constituents of the animal's serum which they are capable of taking up.

(3) Electro-osmotic action is again improbable, because secreting membranes produce ingoing electrical currents as well as absorbing membranes; and, to apply such an hypothesis, it would be necessary to assume that the ingoing current of the cells is active in one case (absorption), the outgoing return current in the other (secretion) involving the further hypothesis of some valvular nature of protoplasm with higher "porosity" in the "in-out" direction in the absorbing, and the "out-in" direction in the secreting, membrane.

(4) Finally, any aspirating action of the blood current in the capillaries of the villi is negligible on account of the low velocity of the current in capillary districts of the circulation.

Prof. W. H. Thompson reported on experiments continued under the committee appointed to examine the effects of peptone and its precursors when introduced into the circulation. The experiments had dealt with the influence of pure peptone, of anti-peptone, and of hetero-albumose on coagulation, on blood-pressure, and on vasomotor irritability. Pure peptone was found to delay but not destroy the coagulability of blood, and to cause a fall in blood-pressure and to lower the vaso-muscular irritability. Antipeptone was found to hasten the coagulation of blood: it causes a very transient fall of arterial blood-pressure, which is immediately followed by a long-continued slight increase of blood-pressure above that present at commencement of the experiment. As to deutero-albumose this substance was not found to give constant results: in some experiments a marked retardation, in others a marked increase of rate of coagulation of blood ensued. It causes a considerable fall in the arterial blood-pressure Further experiments are in progress on the subject.

Prof. Carl Huber brought forward an important and lengthy paper on the modes of ending of nerve-fibres in smooth, cardiac, and striated muscles. Regarding the last-mentioned it was urged that the nucleated "sole" of the motor end-plate is largely an artefact, derived by expression of the interfibrillar substance of the muscle-fibre The mode of ending of the nerve-fibres in the muscle-spindles shows them, in agreement with Sherrington's experiments, to be sensorial end-organs. The methylene-blue method bears out the description of the ending given by Ruffini, and reveals further details of considerable interest.

Prof. K. Huerthle described a method by which the resistance offered by the vascular channels of an organ to the blood-flow through them may be measured The viscosity of the blood which, together with the dimensions of the tubular system, form the two factors on which the resistance depends, was determined by allowing the blood from an artery to flow through calibrated capillary tubes for thirty seconds, the quantity, pressure, and duration of flow being accurately measured. The internal friction of the blood of the dog is about 4·5 and of the rabbit 3·2, that of water being unity. If in any particular organ

the quantity of blood flowing through in a unit of time, the arterial pressure, and the coefficient of viscosity be known, it is easy by Poiseuille's law to calculate the bore and length of a tube through which, under given conditions, the same quantity of blood would flow. The aim of the experiments is to measure and express the resistance through the several regions and organs of the body in this manner.

Prof. A. R. Cushny described rhythmic variations in the strength of the contractions of the mammalian ventricle under the action of certain drugs of the digitalis groups. The variations occur only when the ventricle is beating at a rate different from that of the auricle. If the conjunction of the auricular with the ventricular beat fall at a favourable time, the beat of the ventricle is strong; if at an unfavourable, is weak. The systole of the auricles at a certain stage of the rhythm falls at the systole of the ventricle: the auricle in consequence cannot empty itself. It was also pointed out that the action of nicotin on the mammalian heart is exactly similar to its action as discovered by Langley on the ganglia of the sympathetic system.

Prof. Loeb demonstrated experiments on the influence of the discharge of highly-charged conductors on nerve-muscle preparations. It was known that if a highly-charged conductor be discharged in the neighbourhood of a nerve, the muscle contracts. He found in relation to this the following new facts. (1) If the nerve be placed parallel with the spark discharge of a friction machine, maximal effects are obtained when the electrodes are symmetrical in regard to the nerve. If the nerve be set to one side near one electrode the effects decrease. (2) If the nerve be set at right angles with the spark discharge, minimal effects are obtained when the electrodes are symmetrical to the nerve. Strong effects are obtained by placing the nerve near one electrode. (3) By putting a conductor behind the nerve in Case 1, the effects are effaced or diminished. By putting a conductor between the nerve-muscle preparation and one electrode in Case 2, an increase in effect is produced. It had been shown in the last ten years that the phenomena of heliotropism, long observed in plants alone, are common in the animal kingdom. In both cases the effects of the light are determined by the direction of the rays and the length of waves, the more refractive of the visible spectrum being chiefly effective. It is possible to directly stimulate nerve by electric rays. Apparently the galvanic current does not directly act on living matter; its effects as stimulus being in reality only due to the direct or secondary products of electrolysis.

Prof. Waller gave a demonstration and description of the action of various reagents upon the electrotonic currents of nerve. He has succeeded in completely proving that these currents are in the strictest sense physiological, and they therefore become more than ever of high physiological interest. In the frog's nerve the anelectrotonic current considerably exceeds the katelectrotonic in magnitude. The action of acids, of alkalis, of carbonic acid, of some anæsthetics, and also of tetanisation and of variations of temperature were all dealt with in their bearing upon the ratio and magnitude of the electrotonic currents. Slight acidification diminishes the anelectrotonic current and increases the katelectrotonic: treatment with bases diminishes in a typical manner the katelectrotonic current. The effect of prolonged tetanisation upon the katelectrotonic current is similar to that of acidifdation. Its effect, though less uniform on the anelectrotonic current, yet strongly resembles the effect produced by carbonic acid. Prof. Waller, indeed, holds that his experiments bring strong evidence that the tetanisation of nerve induces in the nerve the production of CO_2 to a thus detectible extent. Electrotonic currents are diminished for a time by exhibition of ether vapour, and are rapidly and permanently abolished by weaker percentages of chloroform vapour. In other words, chloroform rapidly kills the nerve outright, while by ether it is easy to merely diminish or abolish the excitability of the nerve for a temporary period.

Dr. Mackay communicated a paper on the absorption of "ferratin" and of hæmoglobin by the intestinal wall. He had used the microchemical tests for iron devised by Prof. Macallum. He found that the iron of ferratin is absorbed by the epithelial cells of the villi, and that it was passed inwards to the leucocytes. Deposits of iron could further be found in the liver, spleen, and lymph glands. The iron of hæmoglobin is absorbed by the epithelial cells as a compound, probably hæmatin. In this case deposits are also found in the organs of the portal system, and there is indication of some excretion of iron in the bile and in the urine.

Dr. Noël Paton read a paper on the phosphorus metabolism of the salmon in fresh water. Sample salmon were throughout the spring, summer and autumn taken from the mouths of certain rivers, and others from the upper waters of the same rivers. Abundant observations clearly show that the fish do not feed during their stay in fresh water. The muscle substance steadily diminishes, while the ovaries and testes grow at its expense. The fats and proteids lost from the muscles are sufficient to supply these materials for the growing genitalia, and to yield a very large amount of energy for muscular work. The question here discussed is the exchange of phosphorus. It is first shown that in muscle the phosphorus is chiefly in the form of inorganic phosphates, though a comparatively large amount of lecithin and a small amount of nuclein are also present. In the ovary the phosphorus is chiefly combined in the pseudo-nuclein—ichthulin; but it is also present in considerable amounts in lecithin, and in very small amounts as inorganic phosphates. In the testis the phosphorus is chiefly in the form of true nucleins, but there are also a considerable quantity of lecithin and a small quantity of inorganic phosphate. As the season advances the phosphorus in the genitalia increases, while the phosphorus of the muscle diminishes. The loss of phosphorus from the muscle is barely sufficient to account for the gain in the ovary, amply sufficient to yield the increase of phosphorus in the testis. The lecithin lost from the muscle is sufficient only to account for a small part of the lecithin gained by the ovary. The lecithin and ichthulin of the ovary must thus be found by synthesis as these structures grow. The nuclein of the testis must be formed in a similar manner.

The presence of considerable amounts of lecithin in the growing ovary and testis would seem to indicate that this substance is one of the first stages in the construction of nucleo compounds.

Prof. W. P. Lombard gave a communication on the effect of frequent excitations on the contractility of striped muscle. When the muscle is made to give a series of contractions the height of the contraction is seen to increase. The muscle contracted very much higher to an induction shock just after than just before a short period of tetanic excitations. Each of a series of short tetani following each other in rapid succession was, until fatigue appeared, higher than its predecessor. The after effect of excitation is to increase the capacity of the muscle to shorten. When the inertia of the writing lever is increased each of a series of short tetani is seen to begin with a sudden high rise, the throw of the lever carrying the curve above the actual shortening of the muscle. The height of the introductory peak exhibits in repeated tetani a staircase-like growth, and this, in spite of the total contraction being lessened by an increasing growth of contracture heightening the base-line. The effect of the repeated excitations is to cause a more and more sudden and intense liberation of energy.

Prof. Sherrington demonstrated the production of an intense colour of subjective origin by whirling a disc coloured with red on a black-white ground. The disc should contain a black sector of about 170°. From one edge of the black sector broad concentric vermilion arcs are carried into the peripheral white part of the discs for about 90°; from the other edge of the disc similar arcs in the central part of the white field. On rotating the disc so that black follows red in the circumferential field, and precedes red in the central, the outer arcs appear a dull dark maroon, the inner a bright orange. and the spaces between the outer arcs appear deep blue-green, and the spaces between the inner arcs appear primrose-yellow, especially when viewed by a yellowish illumination. Prof. Sherrington offered an explanation for the phenomenon which he based on negative after-images heightened by simultaneous and successive contrast-effects which, as he demonstrated at the meeting. take effect even when speed of translation of a surface prevents the mind from perceiving the space-relations of the distribution of the contrasted tints. It was pointed out that the disc is being used in this experiment similarly to a circular rheotome for summation of effects which taken singly would by reason of their small quantity be imperceptible. It was also demonstrated that by whirling the disc at higher speed the phenomenon becomes altered, the reds and greys then matching over the whole surface of the disc, the greys assuming a pale green tint; when this is obtained, it was urged that one factor

of those previously acting, namely simultaneous contrast, had alone become valent.

Prof. Halliburton and Dr. Mott made a communication on the effects produced on the arterial blood-pressure by the intravenous injection of choline, neurine, and allied substances. Normal cerebro-spinal fluid produced no effect, while that obtained *post-mortem* from cases of general paralysis of the insane produced a fall of blood-pressure. This is not due to a proteid body present; for after coagulation by boiling, or precipitation by alcohol, a similar effect is produced. Neurine hydrochloride in 0·1 per cent. solution gave a similar fall, but in most cases this was followed by a rise and then by a more persistent fall of blood pressure. Choline hydrochloride in 0·2 per cent. solution gave results identical with those obtained by the pathological cerebro-spinal fluids. Blood taken from patients suffering from pseudo-apoplectiform convulsions of general paralysis was precipitated with alcohol, and the filtrate, after evaporation to dryness and solution in saline, injected, and the effect produced corresponded entirely with that obtained with pathological cerebro-spinal fluids and with solution of choline. Normal blood gave a negative result. The fall of blood-pressure produced by these various reagents is cardiac in origin. This was established by plethysmographic tracings and by experiments on the frog's and mammal's heart. This agrees very well with what is found in general paralysis, cardiac weakness, and enfeebled circulation.

Prof. Richet related experiments by which he had succeeded in showing and measuring in the dog the refractory period of the bulbar and cerebral nervous centres. The animal is cooled down to 30° C. and anæsthetised. It will then react to electrical stimulations of the cortex if the stimulations be not too frequent. If the rhythm of these be 1 per second, the responses are equal in magnitude; if 4 per second, there will be one large and then one small response; if 10 per second, there will be no longer a response to each excitation but one to each alternate. Half of the stimuli fall within a refractory period. The duration of the refractory period is 1/10″. It is possible to show that, as was originally indicated by the experiments of V. Kries, volitional impulses have a frequency of repetition of about 10 or 11 in a second.

Dr. F. S. Lee brought forward the results of his continued researches into the functions of the semicircular canals in fishes, especially in regard to maintenance of equilibrium and to locomotion.

Prof. Anderson Stuart made an interesting communication on the canal of Stilling. He also showed models illustrating the horopter.

Mr. O. Grunbaum contributed a communication upon the effects of intermittent retinal stimulation. He exhibited the results of several series of experiments stated in curves with measures of speed of alternation as ordinate-heights and degrees of illumination as abscissæ. The curves so obtained possess each an apex above, denoting that a sensation of continuous stimulation results if the luminosity be below or beyond a certain amount. The curve begins to descend some distance prior to the use of a degree of luminosity such as to produce a blinding after-image.

Dr. A. Grunbaum gave a communication on muscle spindles found in human muscles; the communication was illustrated by microphotograms.

Profs. Boyce and Herdman contributed the results of their investigations on "green oysters." They had demonstrated copper in comparatively large quantity in the green leucocytes of the American oyster. The green colour in these oysters is in direct proportion to the copper present. The copper indicates a pathological condition of these American oysters. They were not prepared to state whether copper in the food of the oyster can bring about the condition, but there is abundant evidence to show that it can occur where no copper mines or other evident sources of copper are present. The normal copper of the hæmocyanin of the blood, which is probably constantly circulating through the body in minute quantity, may cease to be removed, and so become stored in certain cells in the oyster. The deposition of the copper in the large quantity found appeared to them the result of a degenerative process.

Prof. Boyce communicated a paper by Dr. Warrington (Liverpool). The effects of ischœmia on the structural features of nerve-cells were shown to be very marked. Also the effect of cutting off from the anterior coronal cells the afferent impulses usually impinging on them was studied in cases where the posterior roots had been divided. Marked changes were found, which were minutely described. On the other hand, attempts to discover changes in the cells of the oculomitorius and facialis nuclei after section of their nerve-trunks failed to detect any changes.

In experiments of the kind mentioned above, in which changes uniformly resulted, the typical picture of alteration is very characteristic; the cell becomes somewhat enlarged, is stained red, with a small amount of blue chromophilic granules at its periphery, the nucleus remaining well-marked. The changes go on to a further swelling up of the cell, a disappearance of its nucleus, and finally shrinkage and ultimate disappearance. The paper was illustrated by microphotographs. The method of staining of the preparations employed had been the methylene-blue and erythrosin modification of Nissl's stain.

Prof. Macallum made a long and important communication on the structures of the nucleus and body of the cell, and described the views at which he had arrived on this profound and difficult subject.

Prof. Wesley Mills contributed interesting papers on the psychic development of young animals, on the functional development of the cerebral cortex, and on cortical cerebral localisation.

Miss F. Welby contributed an interesting account of observations on the effect of curvesthetic vapours on the cardiac muscle of the frog; her remarks being illustrated by the projection of the graphic records of the experiments.

The morning of Tuesday, August 24, was devoted to a combined meeting of the sections Physiology and Botany to discuss the chemistry and structure of the cell. Several members of the section of Chemistry also took part, the opening paper being by Prof. Meldola. Profs. Marshall Ward, Armstrong, Green, Macallum, Remsen, Farmer, and Halliburton, spoke in the discussion.

Prof. Meldola devoted his opening paper to a discussion of the *rationale* of chemical synthesis of bodies formed by living organisms.

The presidential address by Prof. Foster was given in the large Zoology Theatre of the University; it was very numerously attended. It was a retrospect of the history of physiology since the previous meeting of the British Association at Montreal in 1884. It was pointed out that the opportunities for studying physiology had grown larger and more facile. "But there is still a larger outcome from the professional chair and physiological laboratory than the training of students. Each post for teaching is no less a post for learning. Among academic duties the making of knowledge is no less a duty than the distributing of it." "Practical expression has been given to this feeling more vigorously in Canada and the United States than in the old country." "Physiology is destined, in consequence of its containing the study of the actions of the brain, to modify the attitude of the physiologist toward the world, and of the world toward the physiologist. That physiology is, and must always be the basis of the art of healing is a truism, but if a plebiscite limited to instructed, one might almost say scientific, men were taken at the present moment, it would probably enough be found that the most prevalent conception of physiology is that it is something which is in some way an appendage to the art of medicine." But without plunging "into the deep waters of the relation which body bears to mind, this at least stares us in the face that changes in what we call the body bring about changes in what we call the mind. When we alter the one we alter the other. . . . If, as the whole past history of our science leads us to expect, in the coming years a clearer and clearer insight into the nature and conditions of that molecular dance which is to us the material token of nervous action, and a fuller exacter knowledge of the laws which govern the sweep of nervous impulses along fibre and cell, give us wider and directer command over the moulding of the growing nervous mechanism and the maintenance and regulation of the grown one, then assuredly physiology will take its place as a judge of appeal in questions not only of the body, but of the mind; it will raise its voice, not in the hospital and consulting room only, but also in the senate and the school."

ON THE SUMMIT OF MAUNA LOA.

DR. H. B. GUPPY has contributed to the *Pacific Commercial Advertiser*, published at Honolulu, an account of observations made during a three weeks' sojourn upon the summit of Mauna Loa in August last.

The air at first was highly electrified. A red blanket used

by Dr. Guppy crackled under his hands at night, and he could trace letters on its surface in phosphorescent hues with his finger-nail as he lay completely enveloped in its folds. The effects of these meteorological conditions soon showed themselves in the cessation of the action of the skin, in severe headaches and sore-throat; in a tendency to palpitation and dyspnœa, and in sleeplessness, general lassitude and loss of appetite, most of which symptoms were attributed to the great lack of moisture in the air, for when a short spell of damp weather intervened, most of the unpleasant symptoms disappeared. An interesting phenomenon was observed every morning and evening. For about twenty minutes after sunrise and before sunset the shadow of the mountain was thrown back against the sky of the opposite horizon. It seemed as if some artist had been at work on the sky far away, and had painted in the profile of the mountain with a very uncanny blue.

Dr. Guppy's observations on the relative humidity have yet to be worked out, but he remarks that there was occasionally as much as a difference of 20° between the wet and dry bulb thermometers, the usual difference being 10° to 15°. The lowest temperature recorded at night was 15° F., and the minimum reading was usually below 20°. The average minimum temperature for the period, August 9 to 31, was 23°·5. The highest temperature of the air in the shade was 61°·2, the average maximum daily being 53°·6, which places the average difference between the night and day temperature at 30°. This great daily range is about twice what it is at the coast.

STATE OF THE CRATER.

In order to familiarise himself with the principal features of the crater, Dr. Guppy adopted the method of making a rough plan of it with a pocket prismatic compass. In some places the lava crust was thin and fragile, and although he never descended further than his waist, there was always in such localities a chance of a sudden descent into a cavern of considerable depth.

His descent into the crater was made on the north-west side. It was a tedious operation, and the loose boulders had to be trodden on very carefully, as they are often inclined to roll down and crush the intruder. As soon as Dr. Guppy reached near the centre of the great pit the clouds began to pour in on all sides over the lips of the crater. In a few minutes he was enveloped in a dense mist, and any further observation was rendered impracticable. During the prevailing dry clear weather with a cloudless sky, "smoke" is only evident in two places in the crater, one near the centre and the other in the south-west corner from the base of a yellowish cliff, where there are apparently extensive deposits of sulphur. When, however, the sky is clouded, and especially when the air is moist, white vapour may be seen arising from the greater part of the surface of the crater. The change is a little startling, the true explanation being that a large amount of the vapour evolved is only visible in cloudy murky weather. It is, therefore, possible that the accounts of two observers may vary greatly as to the crater's condition, and yet no difference in the condition actually exist. This especially applies to the district on the south and south-west borders of the crater, stretching about a mile to the southward. In cloudy weather white vapour arises from many places in this area. In the bright clear weather that prevails the visitor may see nothing, and even walk unwittingly over numerous cracks and fissures whence the invisible vapour is being discharged. Dr. Guppy took the temperature of several of these fissures. In those where the vapour was only seen in cloudy weather the temperature was about 104° F. When the "smoke" is always visible the temperafure is far higher, 160° F. and over. Many of these cracks and fissures exhibit evidence of having originally given passage to vapours at a very high temperature. The subterranean heat appears now more actively displayed in the district extending a mile to the south of the big crater than in the crater itself. A very large amount of vapour is discharged from the borders of a small crater lying near Pohaku Hanalei, and this is probably the smoke sometimes observed from the Kona coast. It is probable that the next eruption will occur on this, the south south-west slope of the mountain.

INSECT LIFE ON THE SUMMIT.

Curiously enough, insects of various descriptions are common on the summit. One species of butterfly common at the coast is not at all infrequent. The butterflies were more often to be found dead than alive, and those flying about were in a half-drowsy condition and easily caught. There were flies of different kinds, the house-fly and the blue-bottle-fly proving a great nuisance. Besides these there were moths, bees, gnats, and an occasional dead dragon-fly; whilst bugs and other insects were collected as they fed upon the bodies of the dead butterflies. These insects were more common when the wind was southerly, and no doubt they had been brought up to this absolutely sterile region by the wind. Evidently most if not all of the butterflies and moths soon die, and probably the other insects too. The whole matter is, however, very suggestive, and shows how readily insects (even the parasitical bug) may find their way into the upper air-currents.

PALESTINE EXPLORATION.[1]

THE object of exploration is to obtain accurate knowledge of a country, its inhabitants, and its extant monuments and texts. That of Palestine has special interest to Christian races and to Jews, as serving to explain more clearly the sacred literature of their faith.

The results of such exploration may be judged by looking back a century to the time of Bayle, Voltaire and Astruc, when what was regarded as advanced scientific work assumed that the Hebrews were a savage race without literature, that history only began to be written about 500 B.C., and that the oldest civilisation was that of China and India. It is now known that the art of writing was practised in Egypt and Chaldea as early as 3000 B.C., that the Canaanites about the time of Joshua had a civilisation equal to that of surrounding nations, as had also the Hebrew kings; while, on the other hand, Chinese civilisation is only traceable to about 800 B.C., and that of India was derived from the later Persians, Arabs and Greeks. These results are due solely to exploration.

The requirements for exploration demand a knowledge not only of Syrian antiquities but of those of neighbouring nations. It is necessary to understand the scripts and languages in use, and to study the original records as well as the art and architecture of various ages and countries. Much of our information is derived from Egyptian and Assyrian records of conquest, as well as from the monuments of Palestine itself. As regards *scripts*, the earliest alphabetic texts date only from about 900 B.C., but previous to this period we have to deal with the cuneiform, the Egyptian, the Hittite and the Cypriote characters. The explorer must know the history of the cuneiform from 2700 B.C. down to the Greek and Roman age, and the changes which occurred in the forms of some 550 characters originally hieroglyphics, but finally reduced to a rude alphabet by the Persians, and used not only in Babylonia and Assyria but also as early as 1500 B.C. in Asia Minor, Syria, Armenia, Palestine, and even by special scribes in Egypt. He should also be able to read the various Egyptian scripts—the 400 hieroglyphics of the monuments, the hieratic, or running hand of the papyri, and the later demotic. The Hittite characters are quite distinct, and number at least 130 characters, used in Syria and Asia Minor from 1500 B.C., or earlier, down to about 700 B.C. The study of these characters is in its infancy. The syllabary of Cyprus was a character derived from these Hittite hieroglyphics, and used by the Greeks about 300 B.C. It includes some fifty characters, and was probably the original system whence the Phœnician alphabet was derived. As regards alphabets, the explorer must study the early Phœnician, and the Hebrew, Samaritan and Moabite, with the later Aramean branch of this alphabet, whence square Hebrew is derived. He must also know the Ionian alphabet, whence Greek and Roman characters arose, and the early Arab scripts—Palmyrene, Nabathean and Sabean, whence are derived the Syriac, Cufic, Arabic and Himyaritic alphabets.

As regards *languages*, the scholars of the last century had to deal only with Hebrew, Aramaic, Syriac, Coptic and Greek, but as the result of exploration we now deal with the Ancient Egyptian whence Coptic is derived, and with various languages in cuneiform script, including the Akkadian (resembling pure Turkish) and the allied dialects of Susa, Media, Armenia and of the Hittites; the Assyrian, the earliest and most elaborate of Semitic languages; and Aryan tongues, such as the Persian, the Vannic and the Lycian.

The *art and architecture* of Western Asia also furnishes much information as to religious ideas, customs, dress and history, including inscribed seals and amulets, early coins and gems. The explorer must also study the remains of Greek, Roman, Arab and Crusader periods, in order to distinguish these from the earlier remains of the Canaanites, Phœnicians, Hebrews,

[1] A discourse at the Royal Institution by Lieut. Colonel C. R. Conder.

Egyptians and Assyrians, as well as the art of the Jews and Gnostics about the Christian era, and the later pagan structures down to the fourth century A.D.

The monuments actually found in Palestine are few though important. The discovery at Tell el Amarna of about 150 letters written by Phœnicians, Philistines and Amorites—and in one case by a Hittite prince—to the kings of Egypt, proves, however, the use of cuneiform on clay tablets by the Syrians as early as 1500 B.C., and one such letter has been recovered in the ruins of Lachish. The oldest monuments referring to Syria and Palestine are found at *Tell Loh*, on the Lower Euphrates, and date from 2700 B.C. Next to these are the *Karnak* lists of Thothmes III. about 1600 B.C., recording the names of 119 towns in Palestine conquered after the defeat of the Hittites at Megiddo These lists show that the town names which occur in the Bible are mainly Canaanite and were not of Hebrew origin. The Canaanite language of this period was practically the same as the Assyrian, excepting that of the Hittites, which was akin to the Akkadian. In the next century the Tell el Amarna tablets show that the Canaanites had walled cities, temples, chariots, and a fully developed native art. They record the defeat of the Egyptians in the north by Hittites and Amorites, and the invasion of the south by the Abiri, in whom Drs. Zimmern and Winckler recognise the Hebrews, the period coinciding with the Old Testament date for Joshua's conquest.

An inscription of Mineptah, discovered in 1896, speaks of the Israelites as already inhabiting Palestine about 1300 B.C., and agrees with the preceding. Other Egyptian records refer to the conquests of Rameses II. in Galilee and in Syria, when the Hittites retained their independence; and in the time of Rehoboam, Shishak has left a list of his conquests of 133 towns in Palestine, including the names of many towns noticed in the Bible.

The Hittite texts found at Hamath, Carchemish and Merash, as well as in Asia Minor, belonged to temples, and accompany sculptures of religious origin. They are still imperfectly understood, but the character of the languages, the Mongol origin of the people, and the equality of their civilisation to that of their neighbours, have been established, while their history is recovered from Egyptian and Assyrian notices. The Amorites were a Semitic people akin to the Assyrians, and their language and civilisation are known from their own records, while they are represented at Karnak with Semitic features.

The oldest alphabetic text is that of the Moabite stone about 900 B.C. found at Dibon, east of the Dead Sea, on a pillar of basalt, and recording the victories of King Mesha over the Hebrews, as mentioned in the Bible. Several Bible towns are noticed, with the name of King Omri, and the language, though approaching Hebrew very closely, gives us a Moabite dialect akin to the Syrian, which is preserved in texts at Samalla, in the extreme north of Syria, dating from 800 B.C. The Phœnician inscriptions found at Jaffa, Acre, Tyre, Sidon, Gebal and in Cyprus do not date earlier than 600 B.C., and show us a distinct dialect less like Hebrew than the Moabite. The most important of these early texts is the Siloam inscription in the rock-cut aqueduct above the pool, found by a Jewish boy in 1880. It refers only to the cutting of the aqueduct (in the time of Hezekiah), but it gives us the alphabet of the Hebrews and a language the same as that of Isaiah's contemporary writings. It is the only true Hebrew record yet found on monuments, and confirms the Old Testament account of Hezekiah's work.

The Assyrian records refer to the capture of Damascus by Tiglath Pileser III. in 732 B.C., and of Samaria in 722 B.C., as well as to Sennacherib's attack on Jerusalem in 702 B.C. The latter record witnesses also the civilisation of the Hebrews under Hezekiah, whose name occurs as well as those of Jehu, Azariah, Menahem, Ahaz, Pekah, and Hosea, who, with Manasseh, gave tribute to Assyrian kings.

About the Christian era Greek texts occur in Palestine, the most important being that of Herod's Temple at Jerusalem, forbidding strangers to enter, and those of Siah in Bashan, where also Herod erected a temple to a pagan deity. Such texts are very numerous in Decapolis, where a Greek population appears to have settled in the time of Christ.

The geographical results of exploration are also important for critical purposes. Out of about 500 towns in Palestine noticed in the Old Testament, 400 retain their ancient names, and about 150 of these were unknown before the survey of the country in 1872-82. The result of these discoveries has been to show that the topography of the Bible is accurate, and that the writers must have had an intimate knowledge of the land. Among the most interesting Old Testament sites may be mentioned Lachish, Debir, Megiddo, Mahanaim, Gezer, and Adullam as newly identified; and of New Testament sites, Bethabara, Ænon, and Sychar, all noticed in the fourth Gospel.

The existing Hebrew remains are few as compared with Roman, Arab, and Norman ruins of later ages. They include tombs, aqueducts, and fortress walls, with seals, weights, and coins. The most important are the walls of the outer court of Herod's great temple at Jerusalem, with his palace at Herodium, and buildings at Cæsarea and Samaria. The curious semi-Greek palace of Hyrcanus at Tyrus in Gilead dates from 176 B.C. In Upper Galilee and east of Jordan there are many rude stone monuments—dolmens and standing stones—probably of Canaanite origin, as are the small bronze and pottery idols found in the ruins of Lachish. Sculptured bas-reliefs are, however, not found in Palestine proper, having been probably destroyed by the Hebrews.

This slight sketch may suffice to show the advance in knowledge due to exploration during the last thirty years. The result has been a great change in educated opinion as to the antiquity of civilisation among the Hebrews and Jews, and as to the historic reliability of the Bible records. Further exploration, especially by excavation, may be expected to produce yet more interesting results, and deserves general support, as all classes of thinkers agree in the desirability of increasing actual knowledge of the past. It is no longer possible to regard the Hebrews as an ignorant and savage people, or to consider their sacred writings as belonging necessarily to the later times of subjection under the Persians. Internal criticism is checked and controlled by the results of exploration, and by the recovery of independent historical notices.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Walsingham Medal, given by the Lord High Steward, for original research in botany, geology, zoology, or physiology, is open to all graduates of the University under the standing of M.A. Monographs for the ensuing year are to be sent to Prof. Newton, Magdalene College, by October 10, 1898.

An examination for the Sheepshanks Astronomical Exhibition will be held in Trinity College on November 19 and 20. In addition to papers on astronomy, there will be an oral and practical examination at the Observatory. Candidates must be undergraduates, and, if successful, must become members of Trinity College.

Mr. G. H. A. Wilson, fifth wrangler 1895, has been elected to a fellowship at Clare College.

PROF. JAMES M. CRAFTS, professor of organic chemistry in the Massachusetts Institute of Technology, will succeed the late General Francis A. Walker as the president of the Institute.

THE *London Technical Education Gazette* announces that a course on practical chemistry, dealing with the "manipulation of gases," will be conducted by Mr. M. W. Travers, at University College, on Fridays, at 5.30 p.m., commencing on Friday, November 12. This course will be of great value to those engaged in gas testing, and will deal with methods not hitherto published. A research course for teachers on "The effect of repeated heating on the magnetic permeability and electrical conductivity of iron and steel," is being conducted by Principal Tomlinson, F.R.S., at the South-west London Polytechnic, Manresa Road, Chelsea, on Saturday mornings from 10 to 1, with facilities for continuing experiments, if desired, from 2 to 5. Teachers are admitted free; there are still a few vacant places in the class. Any teachers who wish to join should apply at once to Principal Tomlinson.

THE first volume of the Report of the United States Commissioner of Education, for the year 1895-96, has been received. Though largely concerned with elementary schools, the report contains several noteworthy articles on the higher branches of education. A detailed account is given of the Education Bill of 1896, and the discussions which led to its withdrawal. Current statistics of education in Great Britain form the subject of a special chapter. Some of the features of the educational systems of Germany, Austria, and Switzerland are reported upon, the statistics which the report gives as to higher education in the German-speaking part of Europe being very valuable. It appears from the extensive tables contained in the

report that there are 75 higher seats of learning in Germany, Austria proper, and Switzerland, having altogether 5963 professors, 67,062 students, and 6628 foreign students. There is in Germany one professor for 12·1 students, and an average of 78·4 professors and 926·3 students (of whom 67·2 are foreigners) to one seat of learning. Austria has one professor for 11·7 students, and an average of 80·5 professors and 949·4 students (of whom 91·1 are foreigners) to one higher seat of learning. Switzerland has one professor for 5·9 students, and an average of 96·2 professors and 569·6 students (of whom 208·3 are foreigners) to one higher seat of learning. Among other subjects of articles in the report are: the comparative study of popular education among civilised nations; education in France; education in Mexico and Central America; commercial education in Europe, particularly in Austria, France, and Germany; and the correlation of studies.

ONE of the most gratifying signs of educational progress is the increasing efficiency of technical institutions in the provinces as well as in London. These schools are not only far better equipped than they were a few years ago, but in many cases the members of the teaching staffs are better qualified to impart instruction. The prospectuses and calendars which come before us from time to time testify to a real development of facilities for education in science and technology, and we are glad to observe the advances which technical schools are making all over the country. A prospectus just received from the Technical College, Huddersfield, furnishes an instance of valuable work being done in a large technical college outside London. This college provides full courses, both theoretical and practical, and of an advanced type, in physics, chemistry, biology, art, engineering, weaving and dyeing. There are also separate departments for mathematics, languages ancient and modern, and commercial subjects; whilst a mining section is in process of formation. Of especial importance is the fact that the college library consists of some 10,000 volumes, an annual sum of 160*l.* being devoted towards the purchase and binding of books, periodicals, &c. At the present time an extension, calculated to cost about 13,000*l.*, is being carried out. Improved accommodation will thus be provided for chemistry and physics, and engineering; a room 105 feet by 27 feet has also been set aside for a museum for biology and mineralogy. The number of students of both sexes for the last two or three years averages about twelve hundred. Students can at present take up at the college all the subjects required by the London University for a degree in art or science, and they will be able to continue to their D.Sc. work when the new chemical and physical laboratories are completed. In all departments we notice that practical work is carried on as well as lectures. Dr. S. G. Rawson, the principal, appears to be developing the college on the right lines, and Huddersfield will doubtless benefit by the work he is doing. Financially the college is also in a satisfactory condition. We think both council and staff are to be congratulated upon the care and energy which has been displayed in building up so strong and useful an institution.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, October 29.—Mr. Shelford Bidwell, President, in the chair.—Prof. Stroud exhibited and described the Barr and Stroud "range-finder." The problem of finding the distance of a given object at sea, or in the field, is complicated by shortness of the trigonometrical "base," and by restrictions of time. As a rule, the apparatus must be self-contained, and "snap-shot" readings are obligatory, *i.e.* the range has to be determined from a single instrument and from a single observation. At 3000 yards the errors must not exceed 3 per cent. In foggy weather, or when viewing a nebulous object, this degree of precision is difficult to attain, but under favourable circumstances the authors have determined ranges, at that distance, within 1 per cent. of accuracy. At shorter ranges measurement is more exact; thus an object at about 2000 yards may be estimated to within about 12 yards. Prof. Stroud gave some account of the history and of the general methods employed in these instruments. Two images of the distant object, preferably of a line such as a flag-staff, are received respectively upon two mirrors, two lenses, or two prisms, placed one at each end of a fixed support. From each of these, the light is then directed towards the middle of the instrument, where the two images, after further reflection, are viewed by one eye-piece. The optical system has finally to be adjusted so that the two images, as now seen in the eye-piece, lie in the same straight line. In the instrument designed by the authors this coincidence is attained by translating a small prism parallel to the axis of the supporting rod. The extent of this translation is a measure of the range. Both eyes are used: the right for bringing the two images into alignment; the left for "finding" the object through a small field-glass, and for reading the scale of distances. At night, sightings have to be taken from "points" of light, and as these are unsuited for measurement, the authors convert them into "lines" by the use of cylindrical lenses. Various devices are introduced to prevent overlapping of the images. The instrument is about five feet long, and tubular in form; it is made of copper, so as to have high thermal conductivity to reduce differential heating. Within the outer tube is the interior supporting rod, designed to equalise so far as possible the effects of interior radiations. Several forms of "separating" prisms were exhibited, the best for the purpose consists of two "reflecting" prisms; these receive the two rays and direct both of them into a third prism, whose angle lies in the space between the angles of the others. Mr. Barr drew attention to the gimbal arrangement and the three struts that keep the supporting rod centred in the tube. To give some idea of the precision and scope of the range-finder, he observed that they were there using the equivalent of a 25-feet "circle," and their measurements were comparable to the measurement of 20 secs. of angle on such a circle. The instrument is handled by ordinary seamen, and stands rough usage on board ship for years without injury.—Prof. Stroud then exhibited "a folometer and spherometer." He explained that in determining curvatures and focal lengths, some telemetric method was necessary, and that, owing to want of parallelism of the beam, and duplication of images, a short-focus telescope was always an inefficient telemeter. For the measurement of inaccessible lengths it was therefore better to use some simple form of "range-finder." Such an apparatus could be made with a set of small mirrors arranged in such a manner as to direct two images of the distant object into an eye-piece, with a fixed prism in the path of one of the incident beams. By sliding this instrument along the optical bench one position could always be found at which the two images, as seen through the eye-piece, were in coincidence. He also described a method for determining curvature by interposing a plate of plane glass between the curved mirror and a source of light.—Mr. Ackermann exhibited two experiments. (1) The blowing-out of a candle-flame by the air from a deflating soap-bubble. The bubble was blown at the mouth of an inverted beaker by breathing into a hole cut out at the top. This hole was then presented to the flame, and the flame was immediately quenched. But if the bubble was blown from ordinary air, with bellows, the flame was merely deflected without being extinguished. (2) It was shown that a miniature boat, provided with a false stern, consisting of a linen diaphragm, could be propelled by filling the hollow stern-space with ether, or with some liquid similarly miscible with water. The motion is due to the continuous release of surface-tension behind the boat. Prof. Boys said that when he tried, some years ago, to blow out a candle with a soap-bubble filled with common air, he found the operation very difficult—so difficult that, having once succeeded, he never repeated the attempt. It had not occurred to him, as it had to Mr. Ackermann, that the CO_2 present in the breath played a part in the quenching. With regard to the second experiment, he had seen a small boat propelled by dissolving camphor astern, but he thought the use of a liquid for that purpose was a novelty. —The President proposed votes of thanks, and the meeting was adjourned until November 12.

PARIS.

Academy of Sciences, October 26.—M. A. Chatin in the chair.—Apparatus for measuring the altitudes attained by balloons. Verification of the results furnished by barometers, by M. L. Cailletet. The dial of the aneroid is placed exactly in the focus of a photographic camera, to which such a mechanism is fitted that every two minutes two photographs are taken simultaneously, one of the barometer and another of the earth. From the focal length of the photographic objective, the distance of any two points on the earth, and the distance of these two points on the negative, the calculation of the true height is easily calculated. The apparatus worked perfectly in a preliminary balloon ascent made by MM. Hermite and Besançon.—Report on a memoir of M. Hadamard, entitled

"On the geodesic lines of surfaces of opposite curvatures," by M. H. Poincaré.—Observations on the new Perrine comet (1897, October 16), made at the Observatory of Paris, by M. G. Bigourdan.—Observations of the same comet made at the Observatory of Toulouse, by M. F. Rossard.—On the deformation of quadrics, by M. C. Guichard.—On systems completely orthogonal in space of n dimensions, and on the reduction of more general differential systems, by M. Jules Drach.—On Weingarten surfaces, by M. A. Pellet.—On a new method of reducing the time of exposure in radiography, by M. Gaston Séguy. A thin glass plate is coated on both sides with an emulsion of gelatino-silver bromide, and allowed to dry. This is then enclosed between two flexible screens, formed by M. Becquerel's calcium violet in suspension in celluloid, and the whole pressed together between cards. A photograph of the thorax, using a six-inch coil, with thirty seconds' exposure, was completely satisfactory, every detail being shown with great clearness.—On a new bianodic bulb, with a red phosphorescence. The glass of the bulb is tinged with didymium chloride. The fluorescence is red instead of green, giving twice as much of the X-rays as ordinary glass. The effects on the screen are very brilliant, and can be seen by persons colour-blind to green.—Researches on saline solutions; lithium chloride, by M. Georges Lemoine. Thermal data, showing the heat of dilution of solutions of lithium chloride in water, methyl and ethyl alcohols.—On some basic salts of magnesium, by M. Tassilly. The preparation and properties of the oxybromide $MgBr_2.3MgO.12H_2O$ is described. — The separation and direct estimation of chlorine and bromine in a mixture of alkaline salts, by MM. H. Baubigny and P. Rivals. The separation is effected by potassium permanganate in presence of a large excess of copper sulphate. Analytical results are given, showing the trustworthiness of the method under varying conditions.—On some combinations of metallic acetates with phenylhydrazine, by M. J. Moitessier. Double salts are formed with phenylhydrazine by the acetates of zinc, cadmium, manganese, cobalt, and nickel.—The methods of estimating diabetic sugar, by M. Fréderic Landolph. A comparison of the results obtained in the estimation of diabetic sugar by the polariscopic, fermentation, and copper reduction methods, showed that only the optical can be depended upon.—Optical and reducing power of the flesh of flies, by the same.—Action of the X-rays upon the cutaneous evaporation, by M. L. Lecercle. In the rabbit, the evaporation of a given portion of the skin can be almost completely suppressed, and the effects continue for some time after the exposure. On the human hand, evaporation is somewhat checked, but the action is fugitive, and the evaporation rapidly recovers its original value.—On yellow fever, by M. le Dr. Domingos Freire. A description of the habits and mode of growth of the bacillus, *Micrococcus xanthogenicus*. Attenuated cultures of this bacillus, injected into animals and man, produce a mild form of yellow fever, which confers immunity from the disease. Since 1883 some 13,000 persons have been inoculated, of all ages and nationalities. The subsequent mortality from yellow fever, in spite of violent epidemics which have raged, has not exceeded six per thousand.—Observations on the circulation of the Amphictenia, by M. Pierre Fauvel.—On the differentiation and development of the woody elements, by M. L. Jules Léger. The discovery of a Miocene bat at Grive-Saint-Alban, by M. Claude Gaillard. A complete humerus, and some fragments were discovered.—On the Armand cave, by MM. E. A. Martel and A. Viré. A description of the results of the exploration of a subterranean cave, 207 metres deep, the most remarkable feature being a forest of two hundred stalagmitic columns, of heights varying between three and thirty metres.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 4.

LINNEAN SOCIETY, at 8.—The Attraction of Flowers for Insects: Sir John Lubbock, Bart.—Transfusion-Tissue: its Origin and Function in the Leaves of Gymnospermous Plants: W. C. Worsdell.

CHEMICAL SOCIETY, at 8.—The Properties of Liquid Fluorine: Profs. Moissan and Dewar.—The Liquefaction of Air and the Detection of Impurities: Prof. Dewar.—The Absorption of Hydrogen by Palladium at High Temperatures and Pressures: Prof. Dewar.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Mechanical Features of Electric Traction: Philip Dawson.

FRIDAY, NOVEMBER 5.

RÖNTGEN SOCIETY, at 8.—Address by Prof. S. P. Thompson.

MONDAY, NOVEMBER 8.

ROYAL GEOGRAPHICAL SOCIETY (Queen's Hall, Langham Place), at 8.45.—Introductory Address by the President.—The Jackson-Harmsworth Arctic Expedition: Frederick G. Jackson.

TUESDAY, NOVEMBER 9.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Manchester Ship Canal: Sir E. Leader Williams.—The Mersey Estuary Embankments—Eastham Division: Whately Eliot.—The Mersey Estuary Embankments and other Works—Runcorn Division: Sir E. Leader Williams.—The Irlam Division: W. O. E. Meade-King.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Works of Art from Benin City: C. H. Read and O. M. Dalton.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—The Spectroscope: E. W. Maunder.

THURSDAY, NOVEMBER 11.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Accumulator Traction on Rails and Ordinary Roads: L. Epstein.

MATHEMATICAL SOCIETY, at 8.—On the Poncelet Polygons of a Limaçon: Prof. F. Morley.—On an Extension of the Exponential Theorem: J. E. Campbell.—The Integral $\int P_n^2 dx$ and Allied Forms in Legendre's Functions, between Arbitrary Limits: R. Hargreaves.—The Character of the General Integral of Partial Differential Equations: Prof. Forsyth, F.R.S.

FRIDAY, NOVEMBER 12.

ROYAL ASTRONOMICAL SOCIETY, at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Light, Visible and Invisible: Prof. S. P. Thompson (Macmillan).—Chauncy Maples, D.D., F.R.G.S. (Longmans).—Cheltenham as a Holiday Resort: S. S. Buckman (Cheltenham, Norman).—Twentieth Annual Report of the Local Government Board, 1895–96: Supplement containing the Report of the Medical Officer for 1895–96 (Eyre).—Die Wissenschaftlichen Grundlagen der Analytischen Chemie: W. Ostwald, Zweite Vermehrte Auflage (Leipzig, Engelmann).—The Works of Xenophon, translated by H. G. Dakyns, Vol 3, Part 2 (Macmillan).—Hints to Teachers and Students on the Choice of Geographical Books for Reference and Reading, with Classified Lists: Dr. H. R. Mill (Longmans).—Das Kleine Botanische Practicum für Anfänger: Dr. E. Strasburger, Dritte Umgearbeitete Auflage (Jena, Fischer).—A Geological Map of the Southern Transvaal: Dr. F. H. Hatch (Stanford).—Map of the Transvaal, showing Physical Features, &c.: Dr. F. H. Hatch (Stanford).—My Fourth Tour in Western Australia: A. F. Calvert (Heinemann).

PAMPHLETS.—A Popular Introduction to the Study of the Sun: G. M. Knight (Philip).—Reforms needed in our System of Elementary Education: T. C. Horsfall (Manchester, Cornish).

SERIALS.—Chambers's Journal, November (Chambers).—The Record of Technical and Secondary Education, October (Macmillan).—Natural Science, November (Dent).—Mittheilungen der Prähistorischen Commission der Kais. Akademie der Wissenschaften, 1 Band, No. 4 (Wien).—Journal of the Royal Microscopical Society, October (Williams).—Contemporary Review, November (Isbister).—Good Words, November (Isbister).—Sunday at Home, November (Isbister).—The Transactions of the Royal Irish Academy, Vol. xxxi. Part 4 (Dublin).—National Review, November (Arnold).—Humanitarian, November (Hutchinson).—An Illustrated Manual of British Birds: H. Saunders, 2nd edition, Part 1 (Gurney).

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